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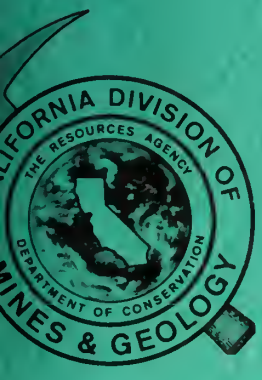
MINERAL LAND CLASSIFICATION: AGGREGATE MATERIALS IN THE WESTERN SAN DIEGO COUNTY PRODUCTION-CONSUMPTION REGION

1982

ALIFORNIA DEPARTMENT OF CONSERVATION
DIVISION OF MINES AND GEOLOGY

SPECIAL REPORT 153



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STATE GEOLOGIST

SPECIAL REPORT 153

MINERAL LAND CLASSIFICATION: AGGREGATE MATERIALS IN THE WESTERN SAN DIEGO COUNTY PRODUCTION-CONSUMPTION REGION

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1982

CALIFORNIA DEPARTMENT OF CONSERVATION
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Sacramento, California 95814

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EXECUTIVE SUMMARY

The Califarnia Division of Mines and Gealagy (CDMG) has classified lond in western Son Diego County according to the presence ar absence af canstruction oggregote resaurces. Speciol attentian has been given ta aggregote suitoble for use in portlond cement cancrete (PCC), the highest quality use of sond, grovel, and crushed rack. The clossificatian wos completed in accordance with guidelines estoblished by the Stote Mining and Geology Boord, in campliance with the Surface Mining and Reclomotion Act af 1975.

In additian ta minerol lond classification, aggregote resource tonnage estimotes ond projected oggregote need over the next 50 yeors were determined far the Western Son Diego Caunty Praductiano-Consumptian (P-C) Region. Aggregate resaurce tonnoge estimates were calculated mainly an the bosis of limited field abservations, onolyses of water-well records, ond o brood understanding af the gealagy af the lacality. Company infarmatian was olso utilized in oreos where it was ovoiloble. Explaratary drilling and rock-quolity labaratory testing to generote independent, detailed data could nat be done. It shauld be recognized, therefore, that the figures for resource tonnoge, olthough based on sound geologic reosoning, are estimates, and, os such, hove on inherent degree of uncertointy. Infarmotian available far colculoting permitted aggregate resources (reserves) wos much more extensive thon thot used far nan-permitted resources. The use af company informatian—which includes aggregate test results, campony drill hale data, and site-specific regulotory restrictions—enobled the CDMG staff ta calculate fairly occurote reserve tannages. These reserves are the valumes ogoinst which the 50-yeor oggregate demonds of the P-C region ore measured.

Figures far tatal aggregote needs over the next 50 yeors were prajected on the bosis of post per-capita cansumption rotes ond projected papulatian increoses. As guideline figures far future oggregate needs, these estimotes ore volid. It is possible thot unfareseen events, such as mossive urban renewol or reconstruction after o mojor disoster, will significontly increase the omount of oggregate needed ta fulfill future needs.

In analyzing aggregate resaurce distribution ond prajected oggregate needs for the next 50 yeors, two mojor conclusions were reoched: (1) there is a shortage af oggregote reserves far the Western Son Diega P-C Regian to supply its needs for the next 50 yeors; ond (2) there is an uneven distributian af sond reserves within the P-C regian.

The totol oggregote reserves for the Western Son Diega P-C Region omount ta 430 million tons. Bosed upan the prajected papulotion increase and predicted per-capito consumptian rotes, this 430 millian tons will supply the Western San Diega P-C Regian far the next 32 years. Appraximately 760 million tans of oggregote will be needed to supply the region to the year 2030, which leoves a 330 million ton deficit of oggregote far the Western Son Diego County P-C Region.

Approximotely 70 percent of the current PCC sond reserves within the Western San Diego P-C Region ore locoted within the Son Luis Rey River, which is situoted in the northern port of the region. This foct demonstrotes the uneven distribution of PCC sond within the region. Lorge quantities af non-permitted PCC sand resaurces lie within all mojor river drainages of the Western San Diega P-C Regian. If additianal sand resource areas are apened up far mining, porticularly those resource oreos which are situoted in close proximity to oreos of ropid urbonizotion, this will help ta alleviate fuel consumptian, pollutian, and traffic resulting from houling sond fram mare distont resource areas. In oddition ta adverse enviranmental impacts, transpartatian af more distol sand reserves to the major metropolitan ond urbonizing oreos will result in a considerable increase in the cost of oggregote ta the consumer.

While aggregate reserves (thase depasits far which use permits have been gronted) ore insufficient ta meet the 50-year needs of western Son Diego Caunty, over 11 billion tons af aggregate resources (those deposits for which no use permits have been gronted) occur in the study areo. Wise lond-use plonning by locol governmentol officiols con assure the availability af these valuable minerol resources ta future generatians of Son Diego County residents.

It is the purpase of this report to tronsmit dato an the type, quantity, lacotion, ond distributian of oggregote resaurces, as well as prajections of future regional need, to the State Mining ond Gealagy Baard and to local governmentol planners os on occurote, unbiased doto base ta assist them in the decision-making pracess.

MINERAL LAND CLASSIFICATION: AGGREGATE MATERIALS IN THE WESTERN SAN DIEGO COUNTY PRODUCTION-CONSUMPTION REGION

INTRODUCTION

The principal objective of this report is to describe and explain he California Division of Mines and Geology's classification of he western San Diego County area into Mineral Resource Zones or aggregate resources, based on guidelines adopted by the Cali- ornia State Mining and Geology Board and under authority ranted by the Surface Mining and Reclamation Act (SMARA) f 1975. Another objective is to inform the State Mining and eology Board of factors relating to the regional significance of he mineral deposits. The Board is authorized to designate areas hich are determined to have regional significance in terms of ineral content. Designation is designed to assist and guide local ead agencies responsible for land-use planning and manage- ent.

Western San Diego County has a population of nearly two illion people and is a rapidly urbanizing area in California. As ith any metropolitan or rural region undergoing urban devel- pment, it is important that the western San Diego County area as adequate supplies of readily available mineral commodities. Minerals used in construction, particularly sand, gravel, or stone sed in concrete, must be available in large quantities and at easonable costs. However, it often happens that, as more land n a region becomes urbanized, nearby available sand and gravel eposits suitable as sources of aggregate tend to be either deplet- d by mining or lost to competing land uses. As this happens, nore distant sources must be used to supply the region's needs or aggregate. Increases in haulage distance bring increases in the ost of aggregate to consumers and also undesirable impacts on he environment. However, decisions made by acting lead agen- ies can significantly extend the life of the nearby aggregate ources.

Woodward-Clyde Consultants has recently completed a simi- ar study of aggregate mineral land classification of the western an Diego County area. The CDMG staff was able to utilize nformation collected during the Woodward-Clyde study for this eport.

BACKGROUND AND PURPOSE

To establish an effective and comprehensive surface mining nd reclamation policy, the California Legislature enacted the urface Mining and Reclamation Act (SMARA) of 1975 (see alifornia State Mining and Geology Board, 1979). SMARA equires the State Geologist to classify, on the basis solely of eologic factors, and without regard to existing land use and wnership, the areas identified by the Office of Planning and Research, and such other areas as may be specified by the board, as one of the following:

(1) Areas containing little or no mineral deposits.
(2) Areas containing significant mineral deposits.
(3) Areas containing mineral deposits, the significance of which requires further evaluation.

The State Mining and Geology Board has subsequently defined the above categories into Mineral Resource Zones (California State Mining and Geology Board, 1979, p. 24).

The Board, upon receipt of the classification information from the State Geologist, transmits the information to the appropriate lead agencies and other interested parties. Following compliance with California Environmental Quality Administration (CEQA) requirements and public hearings, the Board may designate specific mineral deposits judged to be of prime importance for meeting mineral needs as being regionally significant. The objective of the classification and designation processes is to ensure, through appropriate lead agency policies and procedures, that mineral deposits of statewide or of regional significance are available when needed.

On January 13, 1978, the State Mining and Geology Board adopted Resolution No. 22, "Priorities for Mineral Land Classification" (revised November 2, 1978), which scheduled the general order of the work for the State Geologist to classify different areas within the state (Appendix A-2). The purpose of these guidelines is to provide direction to the State Geologist in carrying out the classification of mineral land, and to establish procedures for the designation process. Section I.1a of the "Guidelines" directs the State Geologist to classify specified areas into *Mineral Resource Zones* (MRZs) or *Scientific Resource Zones* (SZs) as defined in Section I.2 of the "Guidelines" (Appendix A-3). In addition, Section I.3 of the "Guidelines" directs that mineral land classification reports identifying areas classified as containing significant deposits of construction material (sand, gravel, and crushed stone) include information about (1) the location and estimated total quantity of construction material that is geologically available for mining, (2) the limits of the market (consumption) region which the potentially producible commodity would serve, and (3) an estimate of the total quantity of material that will be needed to supply the requirements of the consumption region for the next 50 years. This information is utilized by the State Mining and Geology Board in determining the regional or statewide significance of these types of deposits for purposes of designation.

The Mineral Land Classification of Aggregate Materials for the Western San Diego County Production-Consumption Region study was initiated in November 1980 by the State Geologist. The project area includes all of the major metropolitan

portions of San Diego County (Figure 1). The western San Diego County area was assigned a high priority for classification in response to a request by land planners of San Diego County and in recognition that the western San Diego County area is undergoing rapid urbanization.

Classification for other mineral resources will be done following the initial statewide classification of urbanizing areas for aggregate resources.

DETERMINATION OF THE WESTERN SAN DIEGO COUNTY PRODUCTION-CONSUMPTION REGION

In determining the areal limits of the San Diego County mineral land classification, a study of sand and gravel production and consumption was made for the county. The study showed that almost all production and consumption of aggregate within San Diego County takes place within the westernmost 1/3 of the county. For the purposes of this study, this portion of the county is referred to as the Western San Diego County Production-Consumption (P-C) Region, which is shown on Figure 2. The Western San Diego County P-C Region encompasses: (1) the entire metropolitan area of San Diego County (urbanized[1] areas); (2) areas which are expected to urbanize within the next 10-30 years (urbanizing[1] areas); and (3) any resource areas which currently provide or are expected to provide in the future, aggregate material to these urbanized and urbanizing areas. This report restricts mineral land classification of aggregate for San Diego County to the above-described production-consumption boundary.

Figure 1. Lacatian af study area, Mineral Land Classificatian: Aggregate Materials in the Western San Diega Caunty P-C Regian.

Marketing Regions

To ascertain whether or not a deposit has regional or statew significance, it is necessary to know where the commodity produced and where it is consumed. Some mineral commodit such as those obtained from the rare-earth deposits of Mount Pass in San Bernardino County, have a worldwide market a and therefore have worldwide significance. However, low-va bulk commodities such as sand and gravel are generally mark ed regionally, and their significance should therefore be me ured on a regional level. The significance of individual depo in the Western San Diego County P-C Region is discussed in latter part of this report.

Large metropolitan areas usually obtain sand and gravel crushed stone for construction purposes from several sour within their region. The western San Diego area meets its c struction aggregate needs from 46 aggregate mines situated the county (Figure 3). Source areas include major river ch nels, conglomerate formations, and metavolcanic and grani rocks. The 46 mines operate within the jurisdictional boundar of six lead agencies (Table 1).

Table 1. List of lead agencies located within the boundar of the Western San Diego County P-C Region.

CITIES	MINE (See Figure 3 far mine names and lacatians)
* Carlsbad	5
* Chula Vista	
Caranada	
Del Mar	
El Cajan	
Escandida	
* Imperial Beach	
La Mesa	
Leman Grave	
Natianal City	
* Oceanside	5
* Paway	13
* San Diega	7, 8, 9, 11, 12, 16, 17, 18, 21, 36, 42, 43, 44, 45
* Santee	22, 23, 24, 25, 26
* San Marcas	
Vista	

• Lead agencies with mines or mineable aggregate material which meets the quality specifications for Portland cement concrete aggregate.

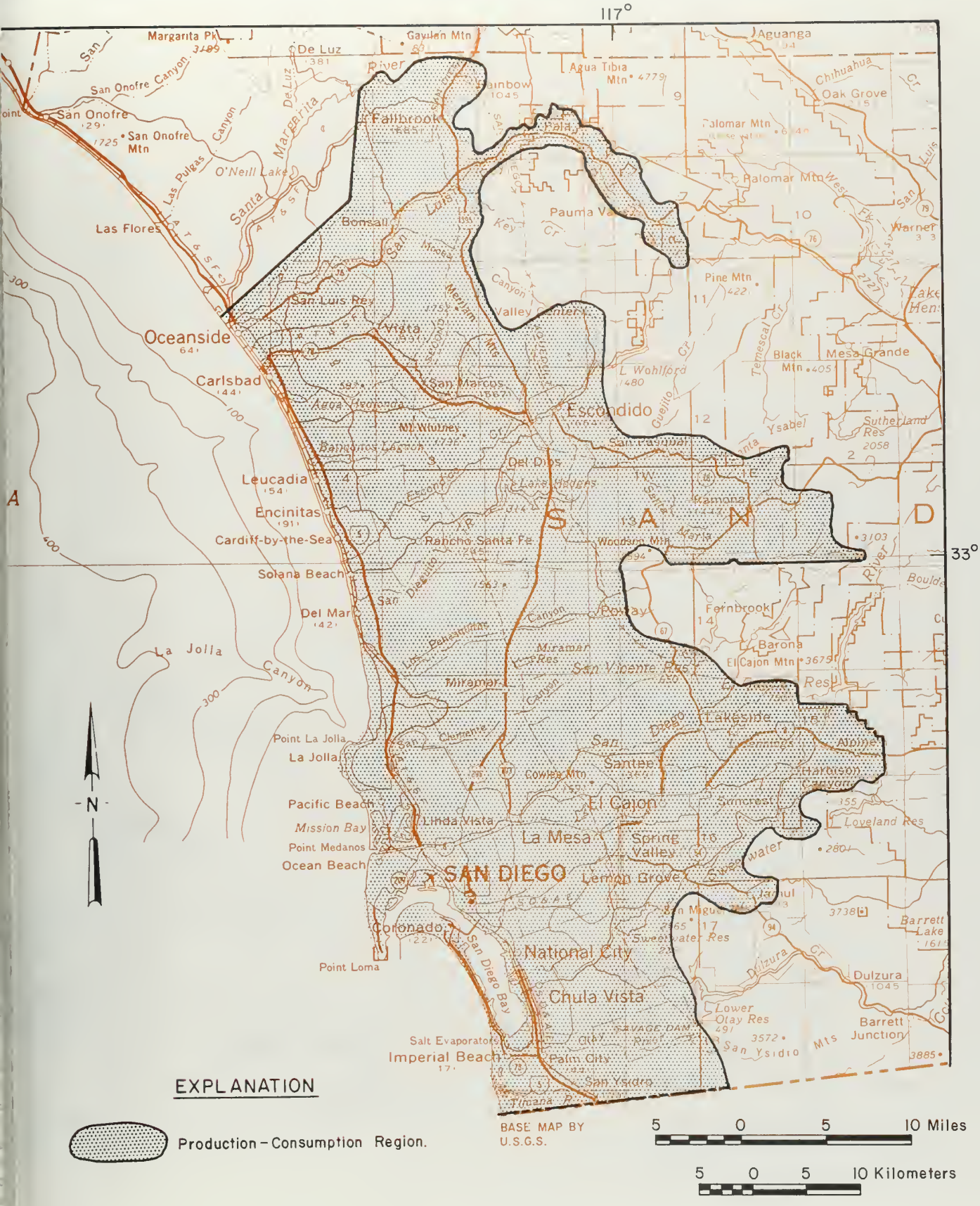
COUNTY	MINE (See Figure 3 far mine names and lacatians)
* San Diega	1, 2, 3, 4, 6, 10, 14, 15, 19, 20, 21, 27, 28, 29, 30, 32, 33, 34, 35, 37, 38, 39, 40, 41, 46

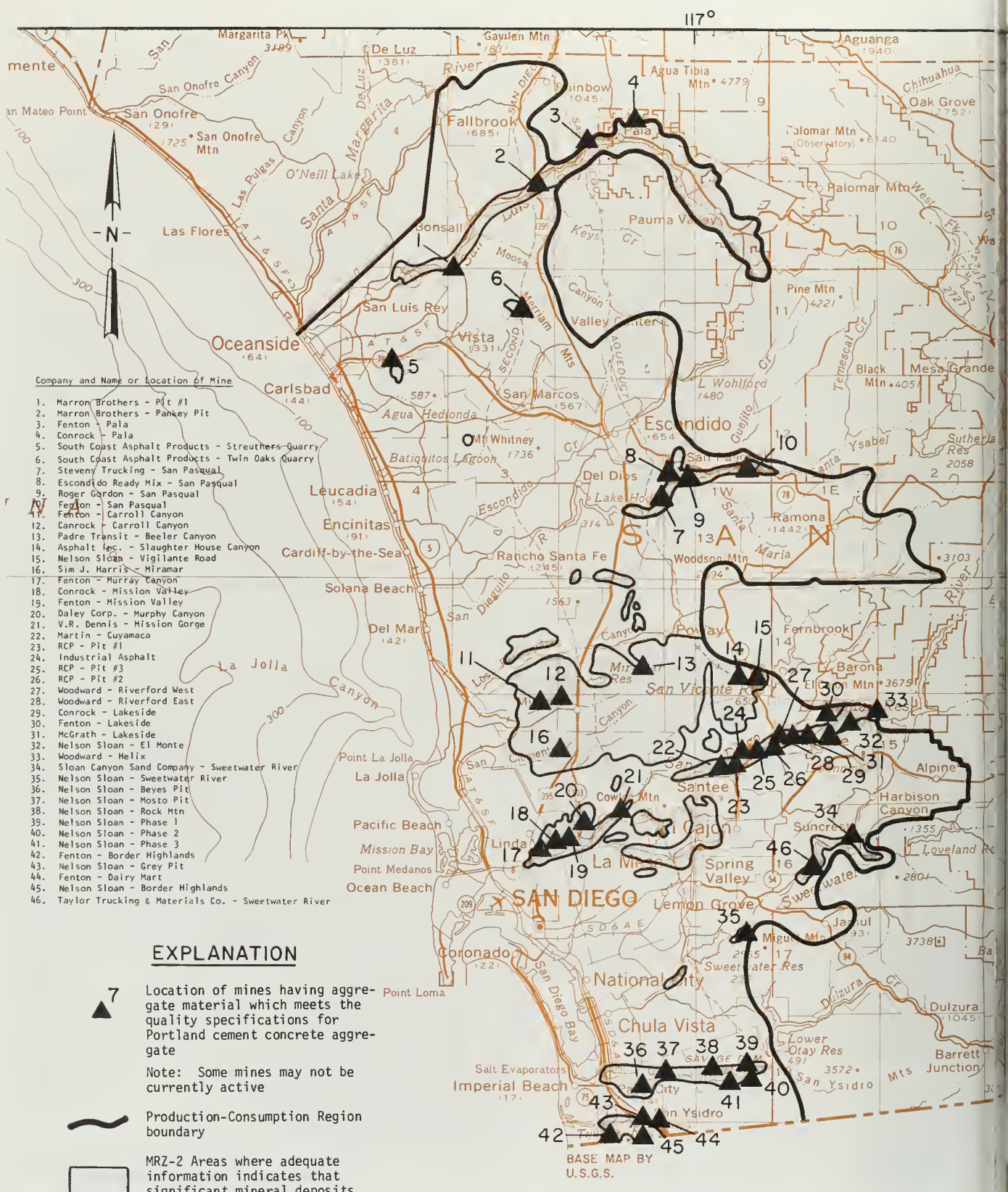
Urbanized and Urbanizing Lines

Maps supplied by the State Office of Planning and Resear (OPR) were used as a starting point to identify urbanizing ar within the western San Diego County area. These maps are pa of a series of eight issued by the OPR in July 1975 as the "Urb Expansion Map of California." The maps were published a scale of 1:500,000 (1 inch approximately equal to eight mile and show "Existing Urban-1970") and "Projected Urban-199 areas (see Figure 4).

Because the "Existing Urban" lines provided by the OPR w outdated and highly generalized, they were only used as a sta ing point for the delineation of urbanized areas. The bound lines of urbanized areas were updated on the basis of 1980 a 1981 aerial photographs supplied by San Diego County, urb areas shown on the most recent U.S. Geological Survey (USG 7-1/2 minute quadrangle maps, and field inspection of urb areas. These urbanized areas are shown on the USGS quadran maps, Plates 1-30, (see Figure 5 for index to quadrangle map

[1] The terms "urbanized" and "urbanizing" as used in this report are based on maps provided by the State Office of Planning and Research (see Figure 4) and are not necessarily agreement with definitions in use by local lead agencies.


117°
33°
Oceanside
Carlsbad
Vista
San Marcos
Escondido
Leucadia
Encinitas
Cardiff-by-the-Sea
Rancho Santa Fe
Solana Beach
Del Mar
La Jolla
Point La Jolla
Pacific Beach
Mission Bay
Point Medanos
Ocean Beach
SAN DIEGO
Coronado
Point Loma
National City
Chula Vista
Imperial Beach
El Cajon
La Mesa
Lemon Grove
Spring Valley
Lakeside
Alpine
Ramona
Poway
Fallbrook
Bonsall
San Luis Rey
Del Dios
Rainbow
Pauma Valley
Palomar Mtn
Pine Mtn
Black Mtn
Mesa Grande
Warner
Aguanga
Oak Grove
Dulzura
Barrett Junction
Jamul
Harbison Canyon
Loveland Res
Sutherland Res
Barrett Lake
Lower Otay Res
Sweetwater Res
Miramar Res
San Vicente Res
Henshaw
Lake Henshaw
Margarita Pk
San Onofre
San Onofre Mtn
O'Neill Lake
Las Flores
Gavilan Mtn
Agua Tibia Mtn
Mt Whitney
Woodson Mtn
El Cajon Mtn
Cowles Mtn
Otay Mtn
San Ysidro
Salt Evaporators
Palm City
Fernbrook
Barona
Santee
Lakeside
Miramar
Del Dios
Valley Center
Ysabel
Guejito
Temescal Cr
Key Cr
Chihuahua Cr
Dulzura Cr
Las Pulgas Canyon
De Luz
Santa Margarita
San Onofre Canyon
La Jolla Canyon
San Diego River
San Dieguito
San Luis Rey River
Pamo Valley
Lake Wohlford
Lake Hodges
Loma Alta Slough
San Diego Bay
Tijuana R.
Otay
Sweetwater
Jamul
Dulzura
Barrett
Lake
Henshaw
Warner
Pine
Black
Mesa
Grande
Sutherland
Res
Loveland
Res
Lakeside
Alpine
Harbison
Canyon
Barona
Fernbrook
Poway
Ramona
Escondido
Vista
Oceanside
Carlsbad
Leucadia
Encinitas
Cardiff-by-the-Sea
Solana Beach
Del Mar
La Jolla
Point La Jolla
Pacific Beach
Mission Bay
Point Medanos
Ocean Beach
Coronado
Point Loma
National City
Chula Vista
Imperial Beach
Salt Evaporators
Palm City
San Ysidro
Otay Mtn
Barrett Junction
Dulzura
Jamul
Lemon Grove
Spring Valley
La Mesa
El Cajon
Santee
Lakeside
Alpine
Ramona
Poway
Fallbrook
Bonsall
San Luis Rey
Del Dios
Rainbow
Pauma Valley
Palomar Mtn
Pine Mtn
Black Mtn
Mesa Grande
Warner
Aguanga
Oak Grove
Chihuahua Cr
Dulzura Cr
Temescal Cr
Key Cr
Guejito
Ysabel
Valley Center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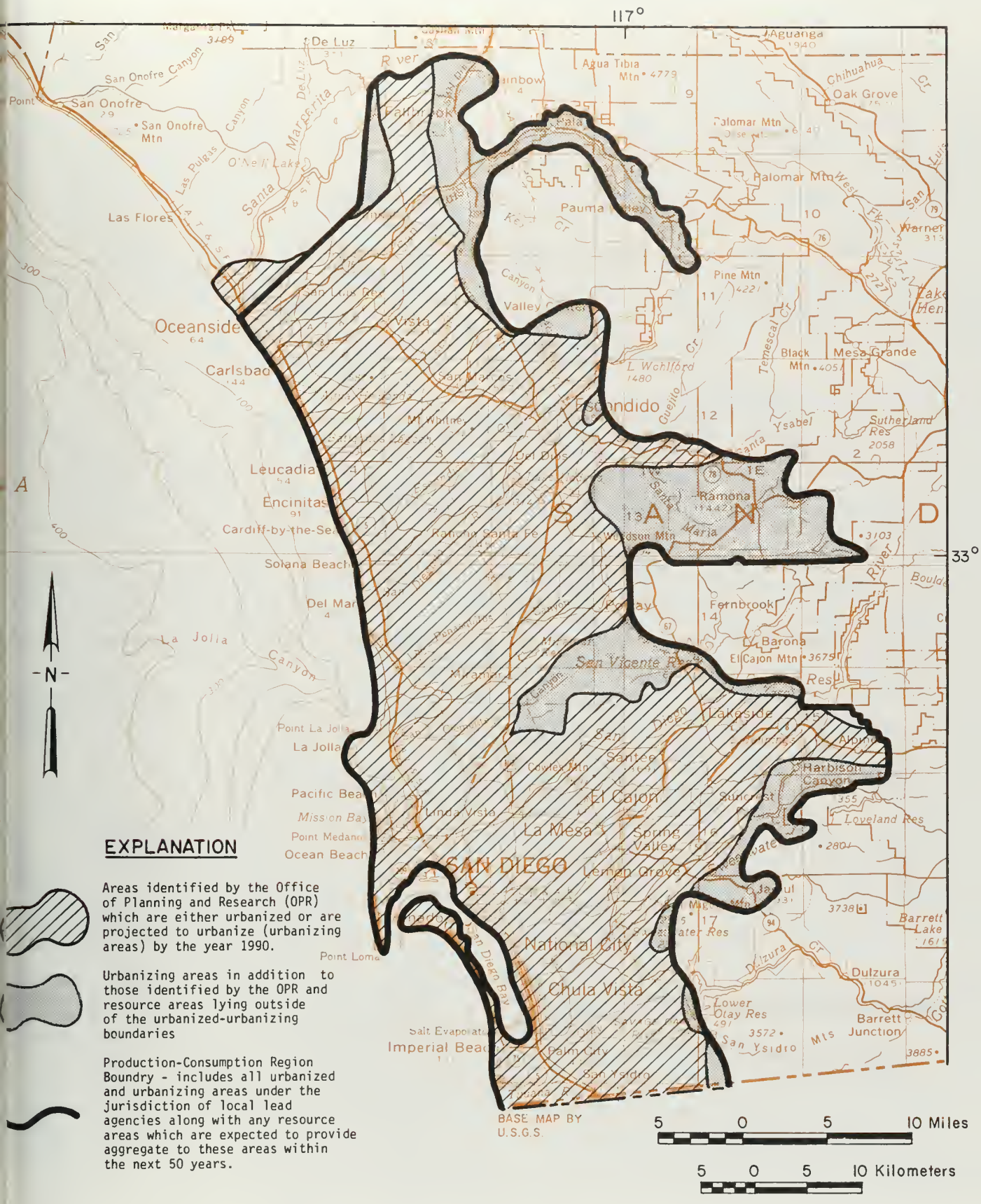
Company and Name or Location of Mine
1. Marron Brothers - Pit #1
2. Marron Brothers - Pankey Pit
3. Fenton - Pala
4. Conrock - Pala
5. South Coast Asphalt Products - Streuthers Quarry
6. South Coast Asphalt Products - Twin Oaks Quarry
7. Stevens Trucking - San Pasqual
8. Escondido Ready Mix - San Pasqual
9. Roger Gordon - San Pasqual
10. Fenton - San Pasqual
11. Fenton - Carroll Canyon
12. Conrock - Carroll Canyon
13. Padre Transit - Beeler Canyon
14. Asphalt Inc. - Slaughter House Canyon
15. Nelson Sloan - Vigilante Road
16. Sim J. Harris - Miramar
17. Fenton - Murray Canyon
18. Conrock - Mission Valley
19. Fenton - Mission Valley
20. Daley Corp. - Murphy Canyon
21. V.R. Dennis - Mission Gorge
22. Martin - Cuyamaca
23. RCP - Pit #1
24. Industrial Asphalt
25. RCP - Pit #3
26. RCP - Pit #2
27. Woodward - Riverford West
28. Woodward - Riverford East
29. Conrock - Lakeside
30. Fenton - Lakeside
31. McGrath - Lakeside
32. Nelson Sloan - El Monte
33. Woodward - Helix
34. Sloan Canyon Sand Company - Sweetwater River
35. Nelson Sloan - Sweetwater River
36. Nelson Sloan - Beyes Pit
37. Nelson Sloan - Mosto Pit
38. Nelson Sloan - Rock Mtn
39. Nelson Sloan - Phase 1
40. Nelson Sloan - Phase 2
41. Nelson Sloan - Phase 3
42. Fenton - Border Highlands
43. Nelson Sloan - Grey Pit
44. Fenton - Dairy Mart
45. Nelson Sloan - Border Highlands
46. Taylor Trucking & Materials Co. - Sweetwater River
EXPLANATION
7 Location of mines having aggregate material which meets the quality specifications for Portland cement concrete aggregate
Note: Some mines may not be currently active
Production-Consumption Region boundary
MRZ-2 Areas where adequate information indicates that significant mineral deposits are present or where it is judged that a high likelihood for their presence exist.
BASE MAP BY U.S.G.S.
SAN DIEGO
Oceanside
Carlsbad
Vista
San Marcos
Escondido
Encinitas
Leucadia
Cardiff-by-the-Sea
Solana Beach
Del Mar
La Jolla
Point La Jolla
Pacific Beach
Mission Bay
Point Medanos
Ocean Beach
Point Loma
Coronado
National City
Chula Vista
Imperial Beach
Salt Evaporators
Fallbrook
Bonsall
San Luis Rey
Rancho Santa Fe
Del Dios
Ramona
Alpine
Harbison Canyon
Spring Valley
Lemon Grove
Dulzura
Barrett Junction
Pine Mtn
Palomar Mtn
Aguanga
Oak Grove
Black Mesa Grande
Fernbrook
Barona
Santee
El Cajon
La Mesa
Lakeside
Suncrest
Jamul
Loveland Res
Sweetwater Res
Lower Otay Res
Las Flores
San Onofre
Margarita
De Luz
Santa Margarita River
San Luis Rey River
San Dieguito River
San Vicente Res
Woodson Mtn
Gaytan Mtn
Agua Tibia Mtn
Mt. Whitney
Cowles Mtn
Aguanga
Pala
Pauma Valley
Keys Cr
Moosa Canyon
Valley Center
Escondido Cr
Lake Hodges
Batiquitos Lagoon
Agua Hedionda
Las Pulgas Canyon
O'Neill Lake
La Jolla Canyon
Mission Gorge
Mast Canyon
Sycamore Canyon
Pomerado
Poway
Mira Mesa
Black Mtn
Ysabel Cr
Temescal Cr
Guejito Cr
Aqueduct
Mts
Mtn
Res
Cr
Canyon
Valley
Lake
Creek
River
Bay
Point
Junction
Observatory
Salt Evaporators
Imperial Beach
San Ysidro
Tijuana
Dairy Mart
Border Highlands
Grey Pit
Phase 1
Phase 2
Phase 3
Beyes Pit
Mosto Pit
Rock Mtn
Sweetwater River
Sloan Canyon Sand Company - Sweetwater River
Helix
El Monte
Lakeside
McGrath - Lakeside
RCP - Pit #1
RCP - Pit #2
RCP - Pit #3
Industrial Asphalt
Martin - Cuyamaca
Mission Valley
Murphy Canyon
Daley Corp.
Vigilante Road
Slaughter House Canyon
Beeler Canyon
Miramar
Murray Canyon
Carroll Canyon
San Pasqual
Twin Oaks Quarry
Streuthers Quarry
Escondido Ready Mix
Stevens Trucking
Taylor Trucking & Materials Co.
Fenton
Conrock
Marron Brothers
Pankey Pit
Pit #1
Pit #2
Pit #3
Riverford West
Riverford East
Lakeside
Mission Valley
Mission Gorge
Carroll Canyon
Miramar
Murray Canyon
Vigilante Road
Sweetwater River
Border Highlands
Dairy Mart
Grey Pit
Phase 1
Phase 2
Phase 3
Beyes Pit
Mosto Pit
Rock Mtn



gure 4. Urbanized and urbanizing areas in western San Diego County.

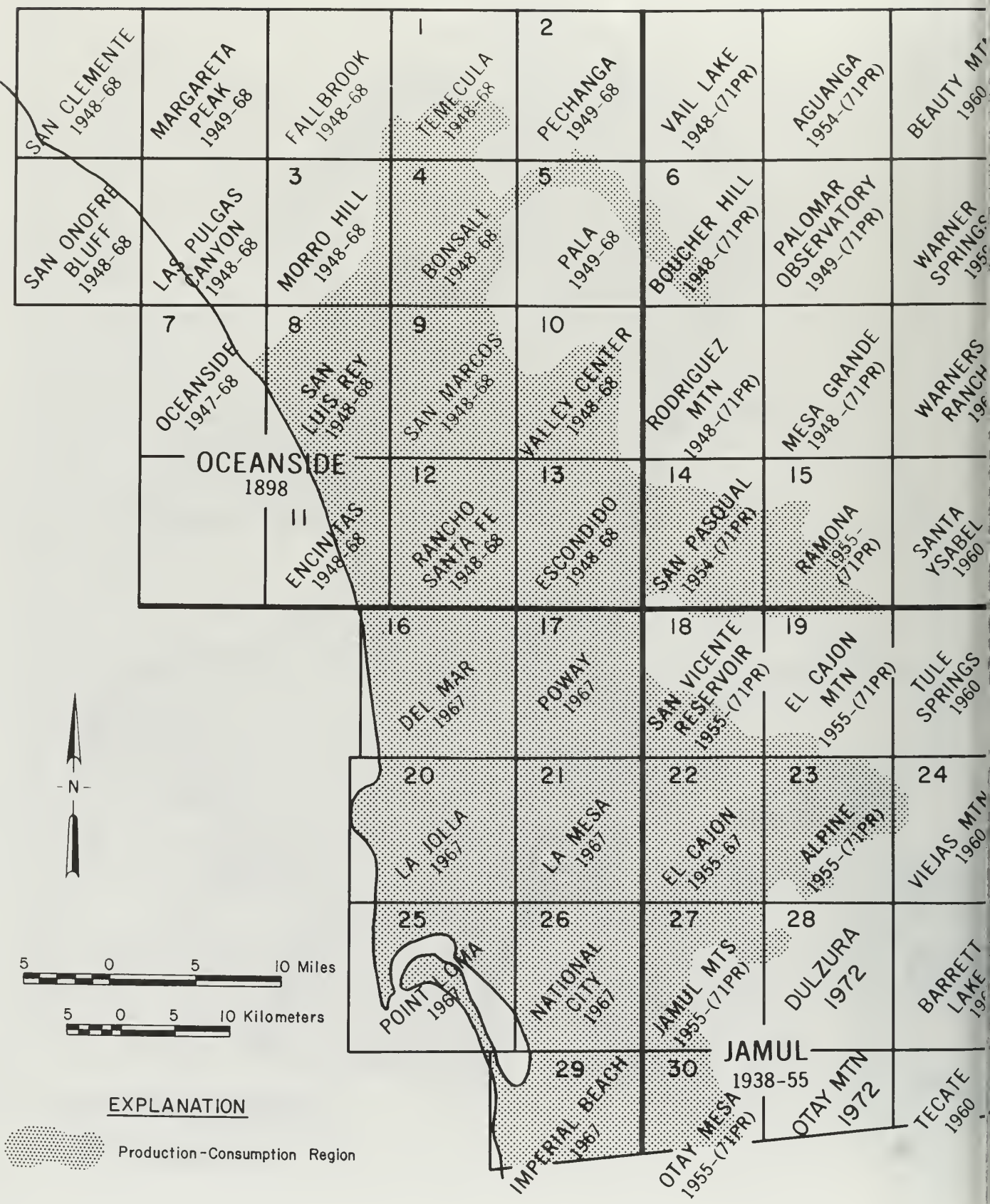


Figure 5. Index map of U.S. Geological Survey quadrangles covering the Western San Diego County P-C Region (numbers refer to plate numbers).

OPR "Projected Urban" lines were used as a basis for establishing "urbanizing lines." Because the OPR maps were produced several years ago, the "Projected Urban" boundaries were modified at the Board's request to reflect current conditions. These modified lines (urbanizing lines) are shown on the USGS quadrangle maps, Plates 1-30. Modification of the "Projected Urban" lines was accomplished by obtaining information from the San Diego County's Regional Land Use General Plan, 1979, which shows anticipated urban development areas to the year 1995. In some areas, these county urban development lines were further modified by CDMG staff to reflect anticipated urbanization beyond 1995. All information collected for the modification of OPR "Projected Urban" lines was transferred to uniform scale, 1:24,000 base maps; final urbanization boundaries were drawn on the basis of the outer line approach.

OVERVIEW OF AGGREGATE

Uses

Sand, gravel, and crushed rock are included among mineral commodities classed as "Construction Materials." These commodities, collectively referred to as aggregate, provide bulk and strength to portland cement concrete (PCC), asphaltic concrete, and plaster or stucco. Aggregate is also used as road base, subbase, and fill. Aggregate normally provides from 80 to 100 percent of the material volume in the above uses.

The emphasis in the western San Diego County classification is placed on portland cement concrete (PCC) aggregate. The material specifications for PCC aggregate are more restrictive than for other aggregate types; consequently, fewer sand and gravel deposits satisfy these specifications. Those deposits that are acceptable for use as PCC aggregate are thus the scarcest aggregate resources in the county and are of the most concern in terms of planning future availability of this commodity.

Economic Significance

During the year of 1980, approximately 11 million tons[1] of aggregate were produced in San Diego County, almost all of which was consumed within the Western San Diego County P-C Region. This amounts to roughly one-tenth of California's average annual production over the same period. The total value of aggregate at the plant site, for the Western San Diego County P-C Region amounted to approximately $45 million.[1]

In the western San Diego County area, aggregate sells for an average of about four dollars per ton[1] at the plant site after washing, sizing, and stockpiling. This price is relatively high when compared to the overall state average of about three dollars per ton.[1] The main reason for this higher price is the relatively lower overall quality of aggregate deposits within the Western San Diego County P-C Region. Production of aggregate from the Poway Conglomerate, the main source of coarse aggregate in the region, entails extensive processing to separate high percentages of waste from the usable aggregate material. However, the plant site cost of aggregate constitutes only part of the value of the product when delivered to the consumer. The remainder is the cost of handling, haulage charges, mixing, and profit. Of these, haulage distance is the most significant factor determining the cost of the final product at the delivery point. If transportation cost is added to the total cost of aggregate in the Western San Diego County P-C Region, the total value of aggregate sold amounts to approximately $65 million.[2] This significantly higher cost demonstrates the need to maintain a nearby source of aggregate if the price to the consumer is to be held down.

The significance and value of aggregate as basic construction materials have multiplier effects. Aggregate is an essential part of the construction industry. Developers, building and freeway/road contractors, cement manufacturers, asphalt producers, carpenters, electricians, truck drivers, and mechanics, to name a few, depend directly or indirectly on the flow of aggregate. Therefore, the availability of aggregate and its proximity to the markets are critical factors in the strength of the local economy.

Development and Production

QUALITY SPECIFICATIONS

This report deals with the classification of aggregate resources, with particular emphasis on PCC aggregate. This emphasis requires that physical and chemical rock material specifications, as determined by laboratory testing, be known before any specific geologic deposit is assigned an MRZ-2 classification.

Aggregate raw material at the pit or quarry site is rarely all physically or chemically suited for use as PCC aggregate. Therefore, every potential deposit must be tested to determine how much of its various components can meet specifications for PCC or other uses and what processing is required.

These specifications for various uses of aggregate material have been established by several agencies, such as the Water and Power Resources Services (formerly the U.S. Bureau of Reclamation), the U.S. Army Corps of Engineers, and the California Department of Transportation (Caltrans), to ensure that aggregate is satisfactory for particular uses. These agencies, as well as other major consumers of concrete, evaluate aggregate for acceptance by using standard test procedures outlined by such organizations as the American Society of Testing Materials and the American Association of State Highway Officials.

Most aggregate specifications have been established to ensure the manufacture of strong, durable concrete that will withstand the physical and chemical effects of weather and use. For example, specifications for PCC concrete prohibit or limit the use of rock material containing mineral substances such as gypsum, zeolite, pyrite, opal, chalcedony, chert, siliceous shale, volcanic glass, and some acidic volcanic rocks. Gypsum shortens the setting time of cement, pyrite dissociates to yield sulfuric acid and iron oxide stain, and the other substances contain silica in a form that reacts with alkali substances in the cement to cause deterioration.

Specifications also call for various grain-size distributions in the various uses of aggregate. For some uses, such as asphalt paving, particle shape is specified. Specification standards set by the California Department of Transportation in 1975 require that at least 25 percent by weight of coarse aggregate (3/4-inch minus material retained on the No. 4 sieve) used as Class 2 aggregate base material shall be crushed particles. Furthermore, aggregate material (screenings) used with bituminous binder to form sealing coats on road surfaces shall consist of at least 90 percent by weight of crushed particles. Crushed stone is preferable to natural gravel in asphaltic concrete because broken surfaces adhere to asphalt better than rounded surfaces and the interlocking of angular particles strengthens the asphaltic concrete.

[1] Data taken from U.S. Bureau of Mines 1980 statistics

[2] Information provided by the San Diego County Rock Producers Association.

PRODUCTION COSTS

Production costs include the cost of mining and processing raw materials for use as aggregate and also the ensuing costs when utilizing the finished aggregate material in various final products (Portland cement concrete, asphaltic concrete, etc.). These costs can vary greatly, depending on the type of the deposit, character of the deposit, and the end use of the finished aggregate.

UTILIZATION COSTS

The preferred use of one aggregate material over another in construction practices depends not only on specification standards but also on economic considerations. Alluvial sand and gravel is preferred to crushed stone for PCC aggregate because the naturally fragmented and rounded material is less expensive to quarry and because a wet mix made with rounded particles of alluvial sand and gravel has better workability than one made with angular particles. The workability of a wet mix consisting of portland cement with crushed rock aggregate is improved by adding more sand and water. However, this also requires that more cement be added to the mix in order to maintain concrete durability standards. Normally, the additional cement amounts to about a quarter sack per yard of concrete, an additional cost of about $0.75 per yard of mix (1978 prices).

Crushed rock is commonly used for PCC aggregate where shortages of alluvial sand and gravel exist. Although slightly more care is required in pouring and placing a wet mix that contains crushed rock, PCC made with crushed rock is as satisfactory as that made with sand and gravel of comparable rock quality. However, production costs are considerably greater, and the use of crushed rock in regions such as the western San Diego area would involve additional haulage costs, truck traffic, and fuel consumption.

CLASSIFICATION OF MINERAL RESOURCE ZONES

Land in the Western San Diego County Production-Consumption (P-C) Region has been classified by the California Division of Mines and Geology (CDMG) according to the presence or absence of significant sand and gravel deposits and crushed rock source areas. The land classification is presented in the form of Mineral Resource Zones (MRZ) that are shown on the 30 U.S. Geological Survey topographic base maps which accompany this report (Plates 1 through 30). Figure 5 shows the quadrangle maps which cover the Western San Diego County P-C Region.

Establishment of Mineral Resource Zones

Mineral Resource Zones within the Western San Diego County P-C Region are established on the basis of an aggregate-resource appraisal which includes: an analysis of geologic reports and maps; field investigations; an examination of active sand and gravel mining operations; analyses of drill hole data; interpretation of aerial photographs; and evaluation of private company data.

Mineral Resource Zone Categories

Mineral Resource Zones (MRZ-1, MRZ-2, MRZ-3, MRZ-4) are determined on the basis of guidelines set forth in SMARA and in the "Guidelines for Classification and Designation Mineral Lands."

The guidelines for establishing the Mineral Resource Zon are set forth below:

MRZ-1 Areas where adequate information indicates that r significant mineral deposits are present, or where it judged that there is little likelihood for their presenc This zone shall be applied where well-developed lin of reasoning, based upon economic geologic principl and adequate data, demonstrate that the likelihood f occurrence of significant mineral deposits is nil slight.

MRZ-2 Areas where adequate information indicates that si nificant mineral deposits are present or where it judged that there is a high likelihood for their pre ence. This zone shall be applied to known miner deposits or where well-developed lines of reasonin based upon economic geologic principles and adequa data, demonstrate that the likelihood for occurrence significant mineral deposits is high.

MRZ-3 Areas containing mineral deposits, the significance which cannot be evaluated from available data.

MRZ-4 Areas where available information is inadequate f assignment to any other MRZ zone.

AREAS CLASSIFIED MRZ-1

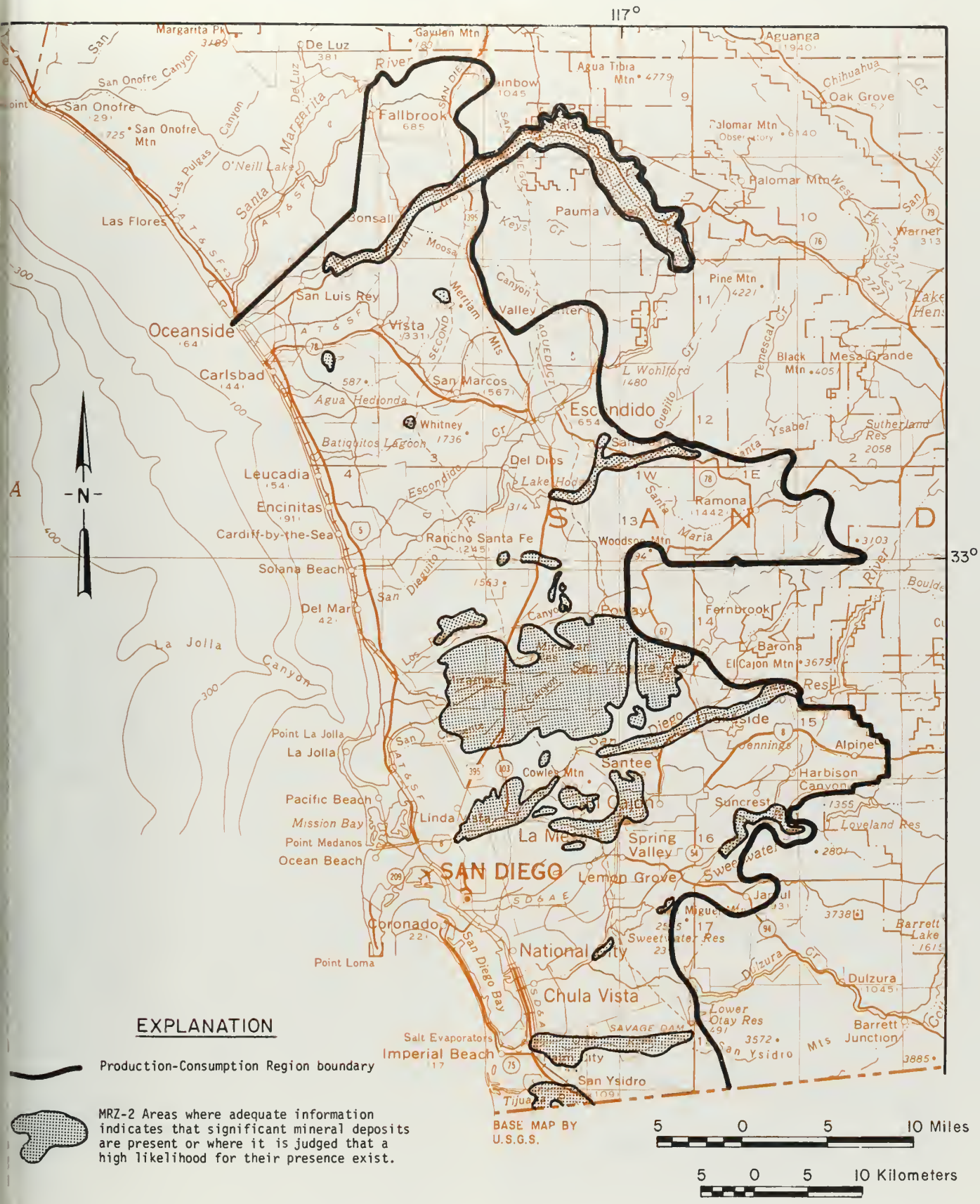
Areas which have been zoned MRZ-1 include both Holocen alluvial areas, consisting predominant of silts and clays, ar older sedimentary formations. Most of the alluvial areas a located near mouths of rivers where fine sediments accumulat Identification of these areas was largely dependent on well-l information and geologic interpretation. Late Cretaceous to E cene claystone, siltstone, and fine sandstone make up the old sedimentary formations which are classified as MRZ-1. Becau most of these areas had little or no well-log information, MR lines were largely drawn on the basis of available geologic ma ping (Kennedy and Peterson, 1975; Kennedy and Tan, 197 and Evans, 1963).

AREAS CLASSIFIED MRZ-2

Four types of deposits make up the MRZ-2 areas which l within the Western San Diego County P-C Region. These a Quaternary river channel and floodplain deposits, Tertiary ar Quaternary conglomerate and alluvial fans, Cretaceous granit rocks, and Jurassic metavolcanic rocks (see Figure 6 for gener location of MRZ-2 areas and Figure 7 for generalized geolo of these areas). The Quaternary river deposits are the source the majority of the current sand production while the conglor erate and alluvial fans currently provide most of the County coarse material.

Quaternary River Deposits

Six major drainages exist within the Western San Die County P-C Region. These are the San Luis Rey River, the S Dieguito River and Santa Ysabel Creek (both make up the S Pasqual Valley), the San Diego River, the Sweetwater River, t Otay Valley, and the Tijuana River. These alluvial valleys a river channels contain numerous water wells and active sand a gravel pits which provide information for their evaluation.


117°
33°
Oceanside
Carlsbad
Vista
San Marcos
Escondido
Encinitas
Leucadia
Cardiff-by-the-Sea
Rancho Santa Fe
Solana Beach
Del Mar
La Jolla
Point La Jolla
Pacific Beach
Mission Bay
Point Medanos
Ocean Beach
SAN DIEGO
Coronado
Point Loma
National City
Chula Vista
Imperial Beach
Salt Evaporators
San Ysidro
Lemon Grove
Spring Valley
La Mesa
Santee
El Cajon
Alpine
Ramona
Fallbrook
Bonsall
Pauma
Palomar Mtn
Aguanga
Pine Mtn
Black Mesa
Warner
Julian
Dulzura
Barrett Junction
Lower Otay Res
Sweetwater Res
Loveland Res
Sutherland Res
Barona
Fernbrook
Suncrest
Harbison Canyon
Jamul
Barrett Lake
Rainbow
Gavilan Mtn
Agua Tibia Mtn
Oak Grove
Las Flores
San Onofre
San Onofre Mtn
Margarita Pk
De Luz
San Luis Rey
Whitney
Del Dios
Woodson Mtn
Cowles Mtn
Otay Mtn
Lake Hodges
Batiquitos Lagoon
Agua Hedionda
L Wohlford
Black Mtn
Ysabel
Mts
Canyon
Valley
Creek
River
Res
Dam
Lake
Hens
Boulder
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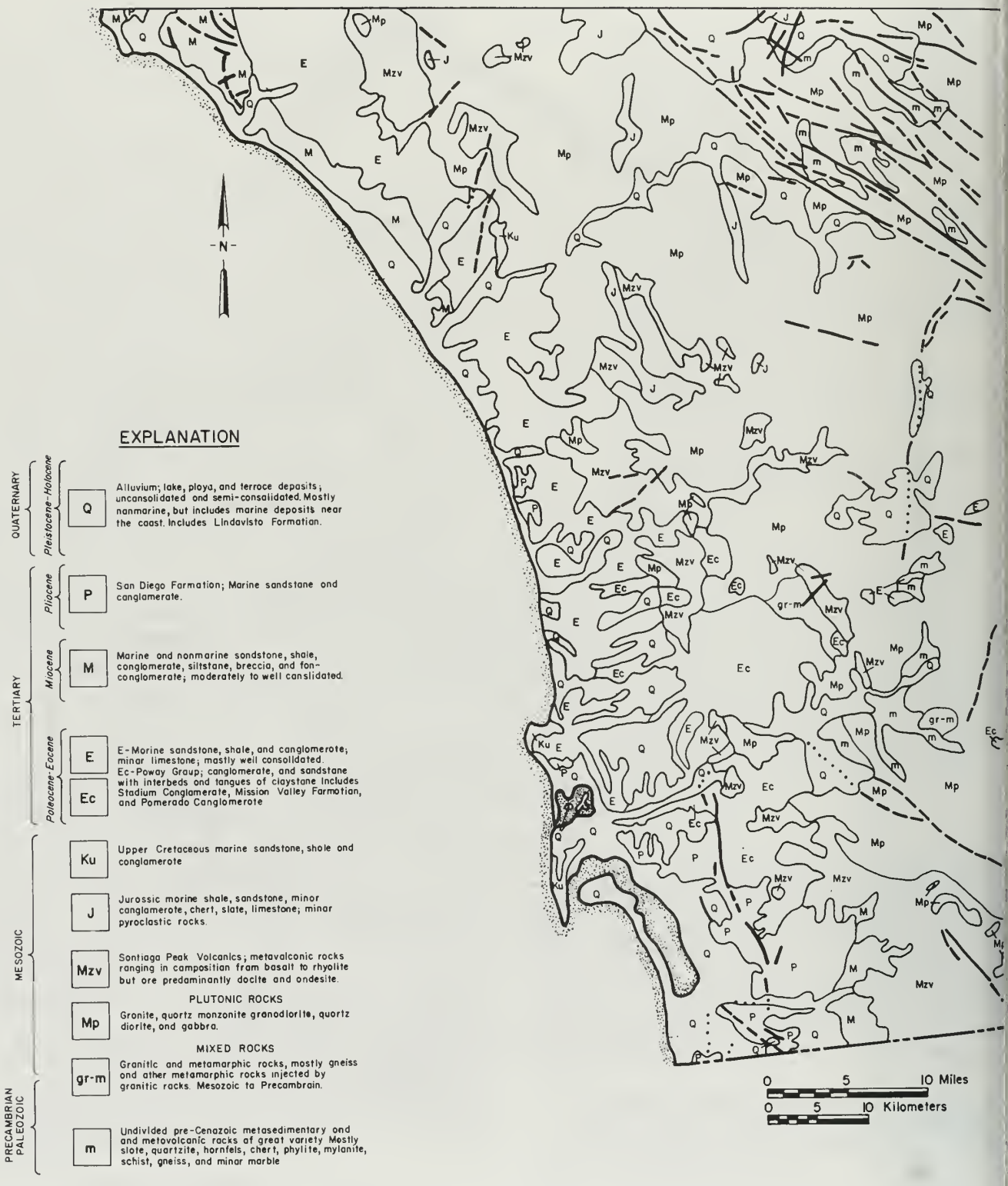
EXPLANATION
QUATERNARY
Pleistocene-Holocene
Q
Alluvium; lake, playa, and terrace deposits; unconsolidated and semi-consolidated. Mostly nonmarine, but includes marine deposits near the coast. Includes Lindavista Formation.
TERTIARY
Pliocene
P
San Diego Formation; Marine sandstone and conglomerate.
Miocene
M
Marine and nonmarine sandstone, shale, conglomerate, siltstone, breccia, and fanconglomerate; moderately to well consolidated.
Paleocene-Eocene
E
Ec
E-Marine sandstone, shale, and conglomerate; minor limestone; mostly well consolidated.
Ec-Poway Group; conglomerate, and sandstone with interbeds and tongues of claystone includes Stadium Conglomerate, Mission Valley Formation, and Pomerado Conglomerate
MESOZOIC
Ku
Upper Cretaceous marine sandstone, shale and conglomerate
J
Jurassic marine shale, sandstone, minor conglomerate, chert, slate, limestone; minor pyroclastic rocks.
Mzv
Santiago Peak Volcanics; metavolcanic rocks ranging in composition from basalt to rhyolite but are predominantly dacite and andesite.
PLUTONIC ROCKS
Mp
Granite, quartz monzonite granodiorite, quartz diorite, and gabbro.
MIXED ROCKS
gr-m
Granitic and metamorphic rocks, mostly gneiss and other metamorphic rocks injected by granitic rocks. Mesozoic to Precambrain.
PRECAMBRIAN PALEOZOIC
m
Undivided pre-Cenozoic metasedimentary and and metavolcanic rocks of great variety Mostly slate, quartzite, hornfels, chert, phyllite, mylanite, schist, gneiss, and minor marble
-N-
0 5 10 Miles
0 5 10 Kilometers

Figure 7. Generolized geology of western San Diego County (modified from Jennings, 1977).

All of these rivers flow in a general westerly direction from the granitic terrain in the central and eastern portions of the county. This granitic bedrock is the source for much of the sand and gravel found within the river deposits.

San Luis Rey River: The San Luis Rey River is situated in the northern portion of the Western San Diego County P-C Region. Alluvial material within the river channel extends upstream from the city of Oceanside for a distance of approximately 30 miles.

Major alluvial fan deposits border the river in the vicinity of Pala, a small community located about 20 miles upstream from Oceanside. These fans border the northeast side of the river for a distance of almost 10 miles.

Three sand and gravel companies (Marron Brothers, Fenton, and Conrock; see Figure 3) are currently mining material suitable for PCC aggregate within the river. The Conrock Company also mines material from an alluvial fan deposit along the San Luis Rey River northeast of the town of Pala.

San Pasqual Valley (San Dieguito River and Santa Ysabel Creek): The San Pasqual Valley forms the floodplain for the San Dieguito River and Santa Ysabel Creek. It extends from Lake Hodges northeastward for a distance of approximately 10 miles to Tims Canyon (Plates 13 and 14). Using all existing well log information, producer information, and geologic interpretation, the entire alluvial plain has been classified as MRZ-2.

Four sand and gravel companies (Stevens Trucking, Roger Gordon, Fenton, and Escondido Ready Mix; see Figure 3) are currently permitted to excavate material from the channel under the directions of the city of San Diego for the purpose of channel maintenance. All of these companies are currently mining sand which is suitable for PCC aggregate. No rock for aggregate is presently mined. The most easterly (headward) parts of the valley, having more coarse sand, are estimated to have approximately 95 percent concrete sand. The quality of sand decreases to the west due to increasing fines. Material from these most westerly parts of the valley contain approximately 50-60 percent concrete sand. Well-log information indicates an average sand depth within the San Pasqual Valley of 85 feet.

San Diego River: For the purposes of discussion, the San Diego River is divided into the lower section and the upper section. The alluvial valley within the lower San Diego River averages a half mile in width and extends from Mission Bay in a northeasterly direction for a distance of approximately 8 miles. Sand and gravel mining has taken place within the lower San Diego River alluvial valley but there is currently no mining activity. Because well-log information within the valley is limited, the main source of information needed for classification came from former mining operations. That portion of the alluvial valley classified as MRZ-2 encompasses roughly a three and one-half square mile area extending from the 163 Freeway east to Mission Gorge. Well logs indicate an average sand and gravel depth of 60 feet. Grain size distribution for the river valley area averages about 25 percent gravel, 60 percent sand, and 15 percent fines. Most of the aggregate within the lower San Diego River is unavailable due to incompatible land uses.

The upper San Diego River extends from the head of Mission Gorge northeast for a distance of approximately 15 miles (see Plates 21, 22, 18, and 19). Because this deposit is centrally located, it has had a long history of mining activity. Eight aggregate companies (Martin, RCP, Industrial Asphalt, Woodward, Conrock, Fenton, McGrath, and Nelson Sloan; see Figure 3) currently have permits to mine in 12 localities within the upper San Diego River alluvial channel. Sand and gravel resources for the area were determined to a depth of 155 feet, which is the maximum sand and gravel depth recorded in well logs. However, a clay layer of unknown thickness, lateral extent, or continuity has been reported by mining companies to occur in parts of the river valley to the west of Magnolia Avenue at approximately 20 feet. Mining in these areas has historically been restricted to this clay layer depth. The clay layer has not been clearly identified in the well logs which were evaluated for the area.

Sweetwater River: The alluvial material within the Sweetwater River extends from the National City area, northeastward for a distance of approximately 24 miles. For the purposes of resource evaluation, the river has been divided into three parts, the lower, middle, and upper Sweetwater (see Plates 26, 27, 22, and 23).

The lower Sweetwater River extends from the National City area northeast to the Sweetwater Reservoir. The area from Willow Drive Bridge up to about a half mile from Sweetwater Reservoir has been classified MRZ-2. An average resource thickness in this area is 40 feet but well logs indicate that alluvium locally is present to depths of 60 feet. The primary material mined is sand. Coarse sand amounts to about 35-40 percent of the deposit and is suitable for concrete sand while finer sands are mostly used for plaster sand. Less than 10 percent of the material within the lower Sweetwater River is gravel. There is currently no mining of aggregate taking place in the lower Sweetwater River.

The middle Sweetwater River extends from the east side of the Sweetwater Reservoir upstream for approximately 5 miles. The only portion of this part of the river classified MRZ-2 is a one-mile long segment of the river channel to the east of Sweetwater Reservoir (see Plate 27). Over 95 percent of the material within this area is suitable for concrete sand. The maximum known mining depth in this area, 15 feet, is the excavation limit for the Nelson Sloan Mine, the only mine having a permit to operate within the middle Sweetwater River. Sand and gravel resources for the middle Sweetwater River were calcuated using this 15 foot depth.

The alluvial valley of the upper Sweetwater River extends from the Jamacha Valley area northeastward for approximately 7 miles (see Plates 22 and 23). All 7 miles have been classified MRZ-2. Two aggregate companies, the Sloan Canyon Sand Company and Taylor Trucking and Materials Company, currently have permits to mine aggregate within the area. Inspection of well logs and company information indicates a fairly uniform thickness of sand and gravel of approximately 60 feet throughout this portion of the river. Roughly 70 percent of the alluvium in the channel consists of sand which meets the specifications for use in PCC aggregate. Approximately 20 percent of the alluvial material is gravel which also meets the standards for PCC aggregate.

Otay River: The mouth of the Otay River is at the southeastern end of San Diego Bay. The river extends eastward from the bay for a distance of almost 10 miles to the Lower Otay Reservoir (see Plates 29 and 30). The entire 10-mile stretch has been classified MRZ-2. Well logs indicate that the depth of sand and gravel in the Otay River is approximately 90 feet. However, mining in the river has not occurred much below the 15-foot level because of a clay layer which has been reported by mining companies to occur at that depth. This clay layer was not clearly identified in the well logs evaluated for the area. Concrete sand and gravel have been mined throughout the river valley. The sand-to-gravel ratio in the Otay River valley is about 50/50. Most of the valley has been mined to the 15-foot level and there is little or no replenishment within the river channel. The Nelson Sloan Company is the only active operator within the Otay River

valley. This company currently has permits to mine in three locatities within the river valley and two localities along terrace deposits adjacent to the Otay River valley.

Tijuana River: The Tijuana River extends from the Pacific Ocean eastward for approximately 5 miles where it crosses the Mexican border. Alluvial material within the river channel averages about 1.5 miles in width.

Land within the Tijuana River alluvial valley which has been classified MRZ-2 extends from the Imperial Beach Naval Air Station area southeastward along the Border Highlands to the International Boundary. Numerous well logs within the area indicate an average thickness of minable aggregate material of 90 feet. This material is predominantly sand to depths of approximately 70 feet. Below 70 feet there is an estimated 50/50 mixture of sand and gravel. Two companies (Fenton and Nelson Sloan, see Figure 3), currently have permits to mine material from the Tijuana River.

San Diego Formation Conglomerate

The conglomeratic part of the San Diego Formation is a pebble, cobble, and boulder conglomerate in a coarse-grained sandstone matrix. The conglomerate has a maximum thickness of 1,300 feet (Kennedy and Peterson, 1975) and is typically poorly sorted, well indurated, and well cemented with iron oxides. The composition of the clasts is extremely varied. "Poway" type clasts (slightly metamorphosed rhyolitic to dacitic volcanic and volcaniclastic rocks) are the primary clast type. Clasts of granitic and low-grade metavolcanic rocks from the local Jurassic and Cretaceous basement rocks are also abundant in many exposures. The formation is typically reddish brown as a result of iron staining from its cement. These rocks are extremely resistant to weathering and form steep natural exposures. A late Pliocene age is assigned to the conglomerate based on its superposition and interfingered relationship with the well-dated marine sandstone part of the formation.

The conglomeratic portion of the San Diego Formation is exposed primarily south of the Otay River valley between Interstate 5 and 805, and in the Border Highlands, between the Tijuana River and the Mexican border (see Plate 29). Both of these areas are classified as MRZ-2. Delineation of these MRZ-2 areas was based primarily on geologic mapping by Kennedy and Tan, (1977). Two aggregate companies (Fenton and Nelson Sloan; Figure 3) currently have permits to mine material from the Border Highlands area south of Monument Road. Approximately 65 percent of the total material currently being mined is coarse and meets the specifications for use in PCC aggregate. The quality of the remaining 35 percent of fine material has not been fully determined. None of the sand-size material in the San Diego Formation conglomerate is currently being used for PCC aggregate.

The Stadium and Pomerado Conglomerates

The Stadium and Pomerado Conglomerates cover a large area from Kearny Mesa on the west to Moreno Valley on the east and from the Rancho Bernardo area to the north to just south of Interstate 8 on the south (see Plates 13, 16, 17, 18, 20, 21, and 22). These conglomerates are the major source of coarse concrete aggregate in San Diego County. Seven sand and gravel companies (Fenton, Conrock, Padre Transit, Asphalt Inc., Nelson Sloan, Sim J. Harris, and Daley Corp.; see Figure 3) have permits to mine aggregate at ten locations within this area.

The entire area described above has been classified MRZ-2. Some well logs were available for areas within the Stadium and Pomerado Conglomerates, but the main source of informatio used for delineating the conglomerate was existing geologic map of the area. The Stadium and Pomerado Conglomerates make u two of the three formations which form the Eocene Powa Group (see Figure 8). They are described together because the are lithologically identical. Both of these conglomerate forma tions are partly intertongued and partially time equivalent wit the third member of the group, the Mission Valley Formation which is classified as MRZ-3 (see page 14, AREAS CLASSI FIED MRZ-3).

The Stadium Conglomerate, the lowermost unit of the gentl westward dipping Poway Group conformably overlies the Friai Formation and is conformably overlain by the Mission Valle Formation (see Figure 8). It consists of massive cobble cor glomerate with a dark yellowish-brown, coarse-grained sand stone matrix. Most of the Stadium Conglomerate is moderatel well sorted with an average clast size in the cobble range. Th sandstone matrix constitutes less than 20 percent of the unit, bu in local stratigraphic sections individual sandstone beds an lenses constitute 50 percent of the unit. Without extensive proc essing, this sandstone does not meet the standards for PCC sanc However, "washed sand" does possess a sufficiently high san equivalent to be utilized in the production of aggregate base an asphaltic concrete products. The clasts within the Stadium Cor glomerate provide the coarse material for the deposit. Up to 8 percent of the clasts within the conglomerate are slightly meta morphosed rhyolitic, dacitic, volcanic, and volcaniclastic rock Quartzites make up the remaining clasts. All of the coars material within the conglomerate meets the quality specifica tions for PCC aggregate. The thickness of the Stadium Conglom erate is highly variable. The depositional surface is generall believed to have been irregular, producing this variable thick ness. Wells drilled in the conglomerate show a great variety c thicknesses. One well which was drilled at the upper end of Sa Clemente Canyon documented by Ellis and Lee (1919) showe a maximum of at least 875 feet of conglomerate materials. Milo (1961) has estimated the maximum thickness at 450 feet. Sti other estimates of 26 to 164 feet were made by Elliott (1973)

The Pomerado Conglomerate is the uppermost formation c the Poway Group. The contact between the Mission Valley For mation and the Pomerado Conglomerate is characterized b occasional thin beds, lenses, and tongues of light brown, mediur grained sandstone. Like the sandstone in the Stadium Conglom erate, extensive processing of the sand is necessary for use a concrete sand. Clast types of the Pomerado and Stadium Cor glomerates are identical. The Pomerado Conglomerate has maximum thickness of 180 feet (Kennedy and Peterson, 1975)

The Lindavista Formation, a dense, orange, silty, fine graine sandstone and pebble-cobble conglomerate of Pleistocene ag unconformably overlies the Stadium Conglomerate in som areas. Portions of the Lindavista Formation that are predom nantly conglomerate are mined along with the Stadium Cor glomerate.

Jurassic Metavolcanic Rock

The Jurassic Santiago Peak Volcanics comprise an elongate belt of mildly metamorphosed volcanic and volcaniclastic roc containing thin interbeds of marine sedimentary rocks. Massiv exposures of these volcanics can be seen from the southern edg of the Los Angeles basin southward to Mexico. The Santiag Peak Volcanics range in composition from basalt to rhyolite bu are predominant dacite and andesite. The succession is typifie by a wide variety of breccia, volcanic conglomerate, and fin grained tuff and tuff breccia.

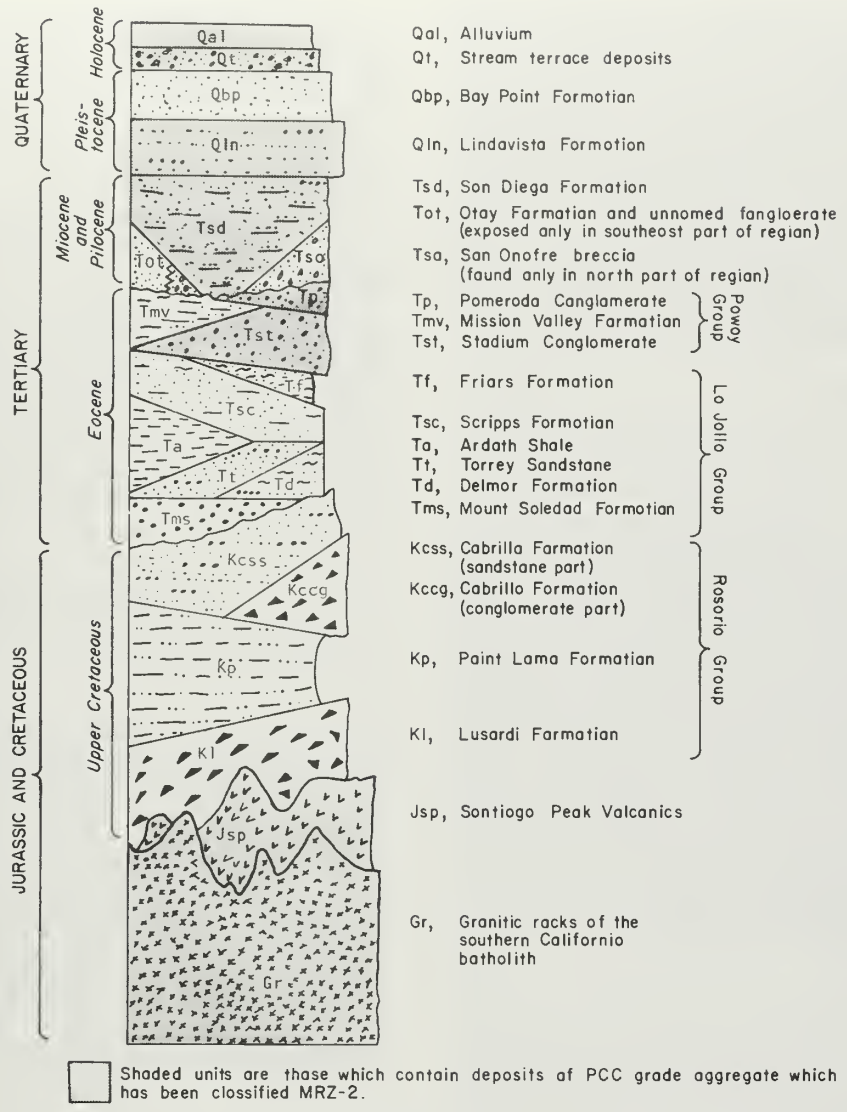

Figure 8. Geologic columnar section of western San Diego County (adapted from Kennedy, 1975).

The Santiago Peak Volcanics are exposed near the eastern dge of the study area, roughly separating the sedimentary oastal plain to the west from the crystalline granitic terrain to he east (see Figure 7). The rock is typically hard and erosion esistant, resulting in highlands protruding through younger edimentary formations. The area underlain by Santiago Peak olcanics extends south from Carlsbad and east through San Marcos, Rancho Santa Fe, Black Mountain, Penasquitos, Mission Gorge, Lake Murray, San Miguel, and San Ysidro Mountains to the Mexican border.

Drill logs and rock-quality test data are lacking for much of ne area underlain by these volcanic rocks. However, examination of outcrops and comparison of test data from producing reas suggest that much of this material could be used as a source f PCC aggregate. Where geologic mapping can be used to place pproximate limits on the area underlain by the formation and st data exist to evaluate the quality of the deposit, the Santiago eak Volcanics have been classified as MRZ-2. Three localities eet these qualifications: (1) the Mission Gorge area, located bout 2 miles southwest of Mission Dam (Plate 21); (2) the stern Carlsbad area, located west of Calavera Lake (Plate 8); and (3) the Rock Mountain area, located directly north of Otay Valley (see Plate 30). All three of these areas have active mining operations which are producing PCC aggregate. All other areas within the Western San Diego County P-C Region that are underlain by the Santiago Peak Volcanics are classified as MRZ-3 because adequate data on rock quality was lacking.

Mesozoic Granitic Rocks of the Southern California Batholith

Mesozoic granitic rocks are exposed throughout much of the eastern half of the Western San Diego County P-C Region (Figure 7). These are plutonic rocks belonging to the Southern California Batholith, which extends for a distance of over 800 miles from the Jurupa Mountains northwest of Riverside to the southern extremity of Baja California. These plutonic rocks consist mainly of tonalite and granodiorite with lesser amounts of gabbro and granite.

Fresh rocks of the batholith have been used extensively for dimension stone, riprap, roofing granules, and decorative rock. Very little of the rock has actually been used for concrete aggregate, yet testing of fresh granitic material in two localities within

the Western San Diego P-C Region has shown that these rocks do meet the specifications for use in PCC aggregate. These two areas have been classified as MRZ-2. One of these localities is situated on the western flanks of the Merrian Mountains (see Plate 9) about 3 miles northeast of the city of Vista. The South Coast Asphalt Company has a current use permit for quarrying rock from this site, but they are not permitted to crush, screen, or wash the quarried rock. Consequently, the material cannot be used for PCC aggregate. The other granitic MRZ-2 site is located within the city limits of San Marcos. This site has been mined in the past but no rock is currently being extracted. The bulk of these granitic rocks have been used for riprap although crushing of material for use as aggregate base has also taken place.

AREAS CLASSIFIED MRZ-3

Areas classified as MRZ-3 are those containing mineral deposits, the significance of which cannot be evaluated from available data. Most of these areas classified as MRZ-3 are located in hilly or mountainous terrain. These areas include rocks from the Santiago Peak Volcanics (see page 26); granitic rocks of the Southern California Batholith; Late Cretaceous sandstones and conglomerates of the Lusardi and Cabrillo Formations (Rosario Group); Eocene sandstones and conglomerate of the Torrey Sandstone, the Mount Soledad, Delmar, Scripps, and Friars Formations (La Jolla Group); and the Mission Valley Formation (Poway Group); the Miocene San Onofre breccia; the Miocene-Pliocene Otay Formation and associated unnamed fanglomerate; and Pliocene and Pleistocene sandstones belonging to the San Diego, Lindavista, and Bay Point Formations. For a detailed description of these formations see Kennedy and Peterson (1975), Kennedy and Tan (1977), and Weber (1963). The stratigraphic relationship between the above-mentioned sedimentary formations are shown on Figure 8.

Portions of the Santiago Peak Volcanics, granitic rocks of the Southern California Batholith, the San Diego Formation, and the Lindavista Formation are classified as MRZ-2. The Lindavista Formation has been included in MRZ-2 areas because it generally forms a thin sediment blanket and as such can be easily removed or mined concurrently with the underlying aggregate deposit. Alone, however, it is of lower quality and quantity than is necessary to be classified MRZ-2. The San Diego Formation has two distinct facies or rock types within it, a sandstone unit that is classified as MRZ-3 and a conglomerate unit which is classified MRZ-2 and is presently being mined in the southern part of the county. Test data were available in some limited areas underlain by Santiago Peak Volcanics or granitic rocks of the Southern California Batholith. This data provided the necessary information needed in order to classify these areas as MRZ-2. All other areas underlain by these rocks were classified as MRZ-3.

Beach sand deposits lie along most of the coast of San Diego County. Beach sand is and has been mined for aggregate in other areas of the world. In San Diego, the quantities are sufficient to meet the criteria of MRZ-2 but no test data is available to judge the quality of the deposits. They are, therefore, classified MRZ-3.

Most of the major drainages in the Western San Diego County P-C Region contain alluvial deposits of an economic nature for use as aggregate material. These areas are classified MRZ-2. Alluvium too fine for economic use is also present in those same drainages and is classified MRZ-1. Also, there are areas where both acceptable and unacceptable quality material are intermixed, usually in layered fashion. These areas are classified MRZ-3 because the economics of mining and processing the acceptable material are not fully known.

In all cases in which rock units or alluvial deposits are classified MRZ-3, test data necessary to judge its quality are lacking. If some part of a deposit is not being or has not been mined for aggregate or if steps have not been taken to begin mining, then such test data are usually not available.

AREAS CLASSIFIED MRZ-4

Areas classified MRZ-4 are those areas for which available information is inadequate for assignment to any other MRZ category.

Deposits that come under this classification in the Western San Diego County P-C Region occur in large tributaries within the major drainage systems such as those of the San Diego River and Sweetwater River systems. Although the nature of the alluvium within the main river channel is known through drill logs and mining operations, that of the deposits in some of the larger tributaries is not. Without further drill-log information, these tributary areas must be classified MRZ-4.

EVALUATION OF AGGREGATE RESOURCES IN THE WESTERN SAN DIEGO COUNTY

An analysis of aggregate supply in the Western San Diego County P-C Region is presented in this section of the report. The analysis was conducted on the basis of a quantitative evaluation of aggregate resources contained in the Western San Diego County P-C Region.

Much of the land within western San Diego County that has been classified MRZ-2 has already been urbanized. As a practical matter, these areas are considered to be unavailable because they have been committed to uses that preclude the extraction of aggregate. Still other unoccupied land is considered to be unavailable because its continuity is broken up into isolated properties by subdivisions, freeways, roads, powerlines, and waterways—making mining economically unfeasible. All of this unavailable land was excluded from the resource sectors.

Data Base

Much of the resource evaluation that follows is based on drill hole records of variable quality collected over a time span extending back to the early part of this century. They describe the types of earth material (silt, sand, gravel, and bedrock types) encountered at various depths. Many of the well logs which were used for resource analysis by CDMG staff were collected by Woodward-Clyde Consultants (1979), from the California Department of Water Resources, and other sources. The quality of drill hole descriptions ranges from poor to very good but only drill hole records that contained descriptions judged to be acceptable for analysis were used in the present study. Well log information provided by Woodward-Clyde and Associates (Woodward-Clyde Consultants, 1979) was also utilized for resource evaluation. Including those well log analyses made by Woodward-Clyde, over 300 such wells were analyzed for determination of resource areas. The location of these wells are shown on Plates 1-30.

In areas where well logs were not available, existing geologic maps were used as a data base (Kennedy and Peterson, 1975; Kennedy and Tan, 1977; and Weber, 1963). Geologic units were field checked in various locations although most MRZ lines were drawn on the basis of existing geologic maps.

Reserves and Resources

Two important terms used in this appraisal of aggregate resources in the Western San Diego County P-C Region are *reserves* and *resources*.

Reserves are aggregate materials believed to be acceptable for commercial use, that exist within property boundaries owned or leased by an aggregate producing company, and for which permission allowing extraction and processing has been granted by the proper authorities. The quantity of reserves is highly dependent on both regulatory restrictions (which are written into the use permit usually issued by either the city or county having jurisdiction over the mining property) and economic constraints. The major regulatory restrictions that affect the total sand and gravel reserve are depth of extraction, setback criteria, and the maximum permissible final slope angle. These restrictions may vary from site to site. To calculate a total reserve, it was necessary to know all of the restrictions for each permitted mining site within the Western San Diego County P-C Region. The major economic constraints that restrict the amount of extractable sand and gravel pertain to depth of overburden, quantity of waste (unusable sands, silts, and clays), and technological limits of extraction (currently set at 100 feet below the water table). All economical mining constraints limiting the volume of extractable material have been accommodated in reserve calculations used in this report.

Resources include reserves as well as all similar potentially usable aggregate materials that may be economically mined in the future, but for which no use permit allowing extraction has been granted. All resources which are not reserves are called *non-permitted resources*. In determining the quantity of non-permitted resources, it is impossible to predict what the regulatory or economic constraints will be if and when these resources are translated into reserves. Consequently, current constraints should be used only as a rough starting point and it should be noted that the quantity of nonpermitted resources may be significantly reduced or increased depending on future constraints. Since many of the regulatory and economic constraints are site specific, only those constraints which seemed to be fairly uniform throughout a particular resource area were used as a basis for placing limits on calculated non-permitted resources.

Resource Sectors

To organize the volume calculations of the aggregate resources, and to inform the State Mining and Geology Board about the resources within specific land-use areas, the State Geologist has utilized the concept of "sectors" to identify those MRZ-2 areas that meet the Board's guidelines as eligible to be designated of regional or statewide significance. Each sector is part of the nonurbanized MRZ-2 land where the geometrical configuration of the deposit is fairly uniform, so that tonnages of the mineral resource present can be estimated with some reliability. Thus, for example, sector boundaries would be established between a bedrock deposit and an adjacent stream channel and its floodplain. The sector concept is used for the convenience of arraying resource information, and is not intended to imply any recommendation for designation or for designation priority.

The economically extractable sand and gravel deposits suitable for PCC aggregate within the Western San Diego County PC Region are considered as 22 sectors grouped into eight general areas for the purpose of making resource estimates. These eight areas are shown on six separate plates (see Figure 9 for index to these plates). Specific sectors are associated with the eight areas as follows: Sectors A-H, San Luis Rey River area; Sector I, San Pasqual Valley; Sectors J-L, Kearny Mesa-Mission Valley area; Sector M, Upper San Diego River; Sectors N-Q, Sweetwater River; Sectors R-T, Otay Valley area; Sector U, Tijuana River; and Sector V, border Highlands.

Much of the data used in this section was extracted from a report by Woodward Clyde Consultants (1979), "Mineral Land Survey, Sand and Gravel Resource Zones, Western San Diego County, California." Further description of the geology of these areas is in the preceding section on areas classified MRZ-2.

Table 2 summarizes pertinent information for each sector. This information includes a tabulation of calculated resources, waste percentages, average thicknesses, rock types and rock densities along with names of operating companies and mines. Table 2 also includes a brief description of the sector location and text reference.

The following section of the text discusses each of the eight resource areas along with their respective sectors.

SAN LUIS REY RIVER AREA

The San Luis Rey River area includes the San Luis Rey River channel from upstream of the community of Oceanside to where the river channel narrows upstream of Rincon, the fan deposits adjacent to the river channel from Pala to Rincon, and a crystalline bedrock deposit southeast of Oceanside. This large area of about 14,607 acres has important sand resources and reserves for supplying the northern part of the PC region. At present, four companies produce PCC aggregate from five locations. The area contains a total reserve of 140 million tons of PCC quality aggregate, of which 99 million tons are made up of sand and the remaining 41 million tons are gravel. The total resources of PCC quality aggregate in the San Luis Rey River area are 2840 million tons, of which 1640 million tons are sand and 1200 million tons consist of gravel. Replenishment of resources in the San Luis Rey River channel is possible during storm runoff by the transport of material from upstream areas into the resource area.

Sector A

This sector, which covers about 587 acres east of Oceanside, is a small hill composed of intrusive rocks related to the Santiago Peak Volcanics and is surrounded by sandstone of Eocene age. Producer data indicates that the crushed rock product is suitable for use as PCC aggregate. At present, the rock produced at the South Coast Asphalt Quarry is used primarily as asphaltic concrete aggregate. With a thickness of up to 300 feet, a density factor of 0.090 tons per cubic foot, and a waste factor of 5 percent (overburden and unusable fines), the quantity of rock in the hill, to drainage level is calculated to be 400 million tons. Of this total, 320 million tons are believed to be acceptable for PCC grade gravel and 80 million tons are PCC grade sand.

Sector B

Sector B makes up that portion of the unurbanized area of the San Luis Rey river which is situated downstream from a narrow portion of the river about 2 miles southwest of Bonsall. This is an alluvial area of about 1,307 acres underlain primarily by sands with lenses of fine sand and silt. Alluvium thickness is approximately 100 feet. Well logs indicate that sand and gravel deposits lie within the lower one half to one third of the alluvium (Plate 37). The waste percentage along this part of the river is 15 percent, and the density of the material is about 0.055 tons per cubic foot. Resource calculations indicate a total of 240 million tons of PCC grade aggregate, of which 40 million tons are coarse PCC grade gravel and 200 million tons are PCC grade sand. There are no companies presently operating in this sector.

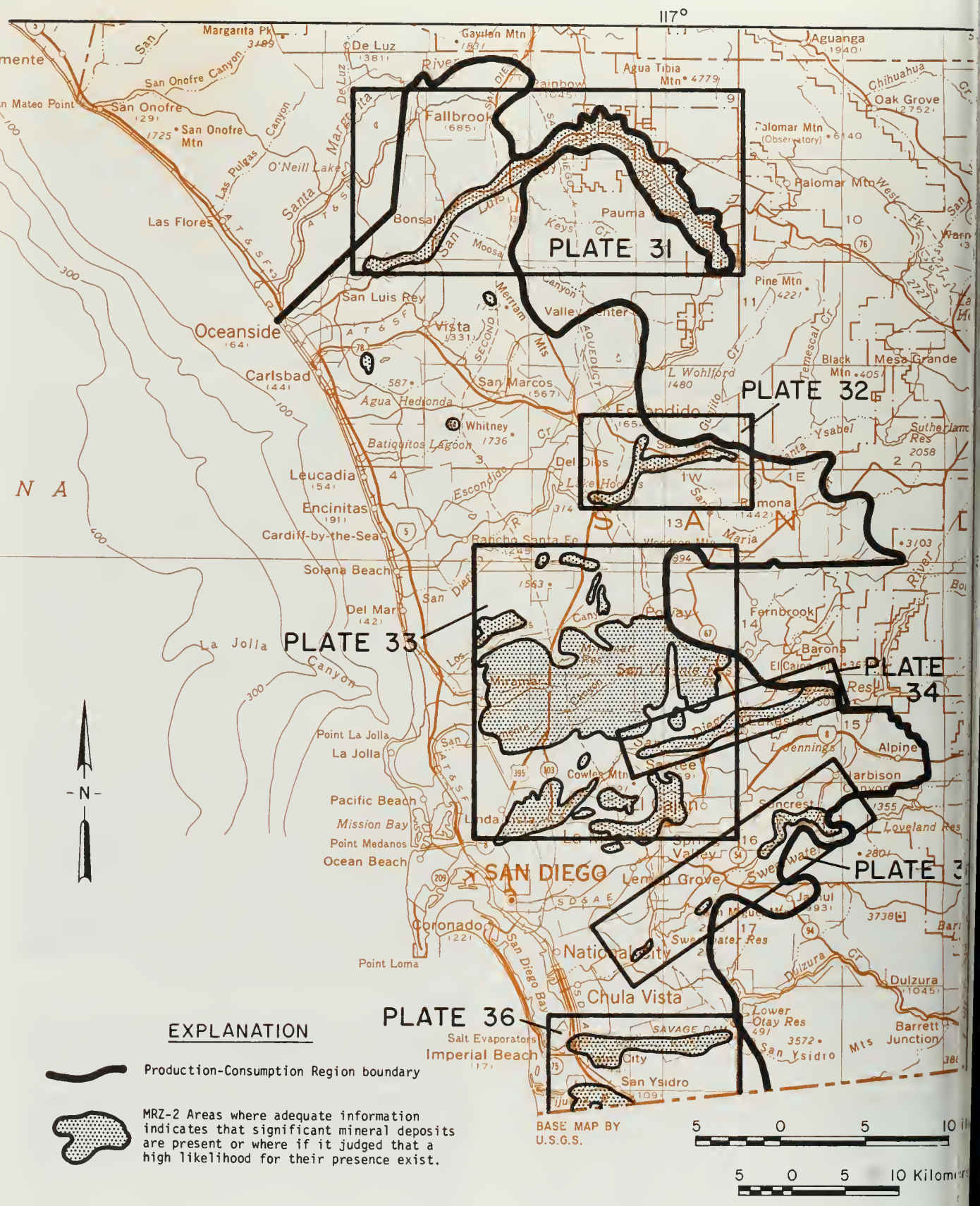

Figure 9. Index map to aggregate resource sectors A-V.

Table 2. Data on resource areas and sectors of the Western San Diego County P-C Region.

Resource Area	Sector	Location	Text ref.	Area (acres)	Rock Type	Density Factor (tons/cu. ft.)	Average Thickness (feet)	Waste (percent)	Resources (millions of tons) sand	Resources (millions of tons) coarse	Reserves (millions of tons) sand	Reserves (millions of tons) coarse	Reserves (millions of tons) other	Operating Company	Name of Mine
San Luis Rey River Area	A-H	northwest S. D. County	pp. 15-21 Plate 31	*14,607					*1640	*1200	*99.4	*41.3	*8.2		
	A	east side of Oceanside	p. 15 Plate 31	587	metavolcanic	0.090	up to 300	5	80	320				South Coast Asphalt	Streuthers Quarry
	B	lower part of river	p. 15 Plate 31	1,307	alluvium	0.055	100	15	200	40					
	C	middle reach of river	p. 18 Plate 31	2,160	alluvium	0.055	95	10	180	40				Marron Bros. Marron Bros.	Panky Pit #1 Panky Pit #2
	D	upper part of river	p. 18 Plate 31	3,740	alluvium	0.055	90-200	7	480	290				Marron Bros. Fenton Conrock	Panky Pit #2 Pala Pala
	E	upper part of river	p. 18 Plate 31	5,818	fanglomerate	0.065	40-80	25	560	270				Conrock	Pala
	F	upper part of river	p. 18 Plate 31	857	fanglomerate	0.065	80	25	90	50					
	G	south of San Marcos	p. 18 Plate 31	53	granitics	0.082	up to 150	5 (est.)	**	**					
	H	northeast of Vista	p. 18 Plate 31	124	granites	0.082	up to 475	5 (est.)	**	**				South Coast Asphalt	Twin Oaks
San Pasqual Valley	I	west central S. D. County	p. 18 Plate 32	*3,521	alluvium	0.055	85	10	*510		*0.8			Stevens Trucking Roger Gordon Escondito Ready Mix Fenton	
Kearney Mesa-Mission Valley Area	J-L	west central S. D. County	p. 19 Plate 33	*35,661					*100	*5,900		*137.5	*13.2		
	J	Kearney mesa area	p. 19 Plate 33	34,961	conglomerate	0.065	up to 500	40	30	5,780				Fenton Conrock Padre Transit Nelson Sloan Asphalt, Inc. Sim J. Harris Fenton Fenton Conrock Daley	Carroll Canyon Carroll Canyon Beeler Canyon Vigilante Slaughter House Canyon Miramar Mission Valley Murray Canyon Mission Valley Murphy Canyon
	K	Mission Gorge	p. 19 Plate 33	386	metavolcanics	0.090	up to 300	5	30	110				V.R. Dennis	Mission Gorge
	L	Lower S. D. River	p. 19 Plate 33	314	alluvium	0.065	60	10	40	10				Fenton Conrock	Mission Valley Mission Valley
Upper San Diego River	M	west central S. D. County	p. 19 Plate 34	*2,150	alluvium	0.055	155	15	*300	*240	*21.8	*1.7	*3.3	Nelson Sloan Woodward Woodward Woodward Industrial Asphalt Martin RCP RCP RCP C.W. McGrath Conrock Fenton	El Monte Riverford East Riverford West Helix Pit S.D. River Cuyamaca Pit #1 Pit #2 Pit #3 El Cajon Lakeside Lakeside
Sweetwater River	N-Q	southwest S. D. County	pp.19-20 Plate 35	*1,133					*60	*20	*22.8	**	**		
	N	lower Sweetwater River	p. 19 Plate 35	150	alluvium	0.055	60	25	10						
	O	middle reach of river	p. 20 Plate 35	183	alluvium	0.055	15	25	10	>10				Nelson Sloan	Sweetwater
	P	upper Sweetwater river	p. 20 Plate 35	343	alluvium	0.055	60	20	20	10					
	Q	upper Sweetwater river	p. 20 Plate 35	400	alluvium	0.055	60	10	**	**				Sloan Canyon Sand	Sweetwater
Otay Valley	R-T	southwest S. D. County	p. 20 Plate 36	*3,193					*150	*280	*0.7	*32.5			
	R	Otay River	p. 20 Plate 36	2,727	alluvium & conglomerate	0.065	70	40	100	70				Nelson Sloan Nelson Sloan Nelson Sloan	Mosto Pit Beyer Pit Phases 1,2,3
	S	Rock Mtn.	p. 20 Plate 36	360	metavolcanics	0.090	up to 450	5	50	200				Nelson Sloan	Phases 5 Rock Mtn.
	T	South of Otay River	p. 20 Plate 36	106	conglomerate	0.070	up to 100	15(est.)		10				Taylor Trucking and Materials Company	
Tijuana River	U	southwest corner of S. D. County	p. 20 Plate 36	*2,197	alluvium	0.055	90	10	*360	*40	**		**	Nelson Sloan Fenton	Grey Pit Dairy Mart
Border Highlands	V	along Mexican border	p. 20 Plate 36	* 475	conglomerate	0.070	up to 200	35		*120		**	**	Fenton Nelson Sloan	Border Highlands Border Highlands
									Total (Million Tons)		3,100	7,800	150	240	40
									Total Resources		11,000				
									Total Reserves				430		

*Value represents total for resource area

*Cannot be shown due to confidentiality of producer data

Note

Resources rounded to nearest 10 million tons.
Reserves rounded to nearest hundred thousand tons.
Total Resources rounded to nearest hundred million tons.
Total Reserves rounded to nearest ten million tons.

Sector C

This sector covers about 2,160 acres. It includes the middle reaches of the river channel from the narrows area (Sector B) upstream to about one mile east of Interstate Highway 15. As shown on the cross section A-A′ (Plate 37), the thickness of alluvium is approximately 95 feet with all but the bottom 20 to 40 feet being sand. The lower sand and gravel bed becomes thicker upstream from Highway 15; the deposit is mostly sand and gravel with a thin cover of sand at the east edge of the sector. Data from the two active aggregate plants in this sector, both operated by Marron Brothers, indicate a waste factor of 10 percent and a material density of 0.055 tons per cubic foot. Approximately 220 million tons of PCC grade aggregate resource are within Sector C, of which 180 million tons are acceptable as PCC grade sand and 40 million tons are acceptable as coarse PCC grade gravel.

Sector D

Sector D covers the upper part of the San Luis Rey River channel and encloses an area of about 3,704 acres. Interpretation of the drill hole records in Sector D indicates that the alluvial fill in the channel thickens considerably upstream from about 90 feet near the boundary with Sector C to over 200 feet in the area upstream of Pauma Valley. In Pauma Valley the thickness of economically extractable material is limited by an ancient lake deposit underlying the area at a depth of about 80 feet. Downstream from the town of Pala, the upper 25-40 feet of alluvium consist predominant of sand. Beneath this sand, the alluvium consists of both sand and gravel. Three producers are mining the sand in this area, Marron Brothers, Fenton, and Conrock.

In calculating the aggregate resource in Sector D, a waste factor of 7 percent and a density of 0.055 tons per cubic foot were used. These factors were obtained from the producers in the predominantly sandy part of the channel and may not accurately represent the large sand and gravel deposits in this sector. However, data from other sand and gravel deposits in the region suggest that these are acceptable approximations. There are 770 million tons of PCC quality aggregate resources in Sector D, of which 480 million tons are sand and 290 million tons are gravel.

Sector E

Sector E encompasses the major part of the alluvial fans adjacent to the San Luis Rey River from Pala to Pauma Valley, a total area of about 5,818 acres. The well logs in the area indicate that the coarse fanglomerate material averages 40 to 80 feet in thickness. Data from the Conrock Company, the only aggregate producer in the sector, shows that about 25 percent of the deposit is waste and that the aggregate material density is about 0.065 tons per cubic foot. About 830 million tons of aggregate resources are calculated for Sector E, which includes 560 million tons of PCC grade sand and 270 million tons of PCC grade gravel.

Sector F

Sector F is an alluvial fan deposit which is located adjacent to the uppermost portion of the San Luis Rey River. The lithologic character of the fan deposit in Sector F is much the same as the aggregate material in Sector E as indicated by the well log information. The sector covers an area of about 857 acres. The average thickness of this fan as recorded in wells is 80 feet. Assuming a density factor of 0.065 tons per cubic foot and a waste factor of 25 percent from the data for Sector E, an aggregate resource of 140 million tons is calculated, of which 90 million tons are acceptable as PCC grade sand and 50 million tons are acceptable as coarse PCC grade gravel. There are no aggregate producers presently operating in this sector.

Sectors G and H

Both Sectors G and H delineate small parcels of land underlain by granitic rocks. Sector G lies within the city of San Marcos, and Sector H is about 3 miles east of Vista. Both sectors encompass areas of land surrounding the sites of quarries where rock samples have been collected for testing by the landowner to demonstrate that the rock is acceptable for use as PCC aggregate. Inadequate geologic mapping beyond the boundaries of the sectors preclude the classifying of the rocks outside of the property lines of either sector as MRZ-2. Sector G is an area of 53 acres and Sector H covers about 124 acres. The density of the granitics in both areas is about .082 tons per cubic foot, and the waste factor is estimated from present crushed rock operations in other areas to be 5 percent.

The resource figures for both sectors are confidential and are included in the overall totals for the region.

SAN PASQUAL VALLEY

Sector I

San Pasqual Valley is an agricultural area of about 3,521 acres in west-central San Diego County, about 5 miles southeast of Escondido. This area is shown on Plate 32 as Sector I. Agricultural land is considered a compatible land use with mining (see page 40, California State Mining and Geology Board, 1979). The MRZ-2 area included in Sector I covers the valley above Lake Hodges, where the width of the alluvial deposit is roughly 2000-3000 feet. A tributary entering San Pasqual Valley from the north is also classified MRZ-2, based on drill hole logs in that area. As is seen on cross section B-B on Plate 37, the alluvial deposit is chiefly sand with lenses of coarse material toward the upper part of the valley. Very little mining of aggregate has been done in San Pasqual Valley, and that only to shallow depths. The average thickness of minable material is about 85 feet. The density of the material is 0.055 tons per cubic foot and the waste is about 10 percent. The total resource for Sector I is 510 million tons, all of which is PCC grade sand. Replenishment of sand resource is possible by transport of sediment from upstream areas by stream runoff. Four aggregate producers which currently have permits to extract aggregate material from the valley are Stevens Trucking, Rodger Gordon, Escondito Ready Mix, and Fenton. Estimates by the San Diego City Engineering and Development Department show that about 500,000 cubic yards (740 million tons) have been removed from the San Pasqual Valley for the past several years, and following establishment of a new channel, a substantial yield of about 100,000 cubic yards per year is expected (City of San Diego, 1982). Total reserves for the San Pasqual Valley as of April 1982 are estimated to be 0.8 million tons.

KEARNY MESA-MISSION VALLEY AREA

The Kearny Mesa-Mission Valley resource area is shown on Plate 33 as Sectors J-L. This large area of about 35,661 acres is immediately north and east of downtown San Diego and has within it three different types of aggregate deposits. One type, the lower San Diego River alluvial material, is predominantly sand; a second type consists of the Stadium and Pomerado Conglomerates of the Poway Group (see section on MRZ-2 areas for description of these units), which yield almost exclusively coarse aggregate before crushing. A third type of aggregate depos

nsists of metavolcanics which must be crushed in order to be ed as aggregate material.

The total resources in this area amount to 6,000 million tons. t of this, approximately 5,900 million tons are acceptable as arse PCC grade gravel and only 100 million tons are acceptable for PCC grade sand. This equates to a sand and gravel ratio about 1:60. Total reserves amount to 150.7 million tons, of ich 137.5 million tons are acceptable as PCC grade sand and .2 million tons are acceptable as coarse PCC grade gravel.

ctor J

Sector J covers an area of 34,961 acres of Eocene conglomerate rane, including Kearny Mesa and the hills to the east, along h several isolated patches to the north and a few areas near ssion Valley, south of Kearny Mesa (Plate 33). A large, ntral part of the sector is on the Miramar Naval Air Station, ich is outside the jurisdiction of local governments. Six pro-cers—Fenton, Conrock, Padre Transit, Nelson Sloan, Asphalt ., Sim J. Harris, and Daley Company—currently have per-ts to mine in ten different locations. The producers in Sector must blend the coarse material with sand from other deposits crushed coarse material to make PCC aggregate. Without ensive processing, only the coarse fraction of the conglomer-deposits can be used in PCC aggregate. Consequently, most he remaining finer material is discarded, giving a waste factor up to 40 percent. The density of the Eocene conglomerate is out .065 tons per cubic foot. The thickness of the conglomerate its can be calculated from geologic maps of the area, showing posures of the Stadium and Pomerado Conglomerates ennedy and Peterson, 1975). The thickness varies from a few s of feet along the west margin, to over 500 feet in the eastern a. A resource of 5,810 million tons underlies Sector J, almost (5,780 million tons) consisting of coarse aggregate.

ctor K

Exposed in the walls along the southwest part of Mission rge underlying an area of 386 acres are metavolcanic rocks of Santiago Peak Volcanics. Crushed rock for concrete aggre-e is being produced from this material by the V. R. Dennis mpany. Data from the company indicates that the density of rock here is about 0.090 tons per cubic foot with about 5 cent waste. The highest exposures stand about 300 feet above San Diego River drainage level, which was the base level used the resource calculation. A total crushed rock resource of 140 lion tons underlies Sector K. About 20 percent of the material 0 million tons) is recovered as sand size material during nor-l crushing operations. The remaining material (110 million s) is coarse aggregate material. Other similar exposures of tavolcanic rocks are nearby, but lack of test data precludes ssifying those areas as MRZ-2.

ctor L

ector L includes two plots of land in the San Diego River aivial plain in Mission Valley with a total area of 314 acres. nton Materials and Conrock Company still control parcels in s sector but have ceased mining the predominantly sand re-s rce. Heavy urbanization surrounds Sector L. Well logs of es drilled in the alluvium of the lower San Diego River show average depth of suitable aggregate of 60 feet. The waste in s material is about 10 percent and the density is about .065 s per cubic foot. A calculated 50 million tons of aggregate ource lies within these nonurbanized areas in Mission Valley. this total, 40 million tons are acceptable as PCC grade sand al 10 million tons are acceptable as coarse PCC grade gravel.

UPPER SAN DIEGO RIVER

Sector M

Within the upper San Diego River alluvial plain twelve aggregate pits supply the urban San Diego area with the majority of its sand and gravel needs. Sector M covers 2,150 acres of contiguous nonurbanized river channel from the upper end of Mission Gorge to within a mile of El Capitan Dam. Drill holes in this area (see cross-section C-C', Plate 38) record an average thickness of suitable aggregate of 155 feet, with the top 20 to 60 feet predominantly sand underlain by sand and gravel and a basal layer of gravel and boulders. Fifteen percent of the material is waste. Using a density factor of 0.055 tons per cubic foot, a total resource of 540 million tons of aggregate is estimated to underlie Sector M. Total resources of PCC quality sand for Sector M are estimated at 300 million tons, of which 21.8 million tons consist of reserves. Coarse PCC quality aggregate resources total 240 million tons, of which only 1.7 million tons consist of reserves. El Capitan Dam stops any major replenishment of these resources from upstream.

SWEETWATER RIVER

The Sweetwater River is in southwestern San Diego County. The river valley is lightly urbanized along most of its length. The upper half of the river is dammed by the Sweetwater Reservoir Dam. Drill log data, diagrammed on the cross-section D-D"' (Plate 38), indicates that some areas of the Sweetwater River floodplain are blanketed by layers of silty fine sand. Mining in these areas is not known to be economically feasible at the present and consequently these areas are classified as MRZ-3. The remaining areas are underlain by an upper layer which is predominantly sand and a lower layer of sand and gravel. These areas have been classified as MRZ-2 and are designated Sectors N, O, P, and Q, which together cover an area of 1,133 acres. A significant portion of the sand reserves for the southern part of the PC region are within these sectors. The alluvium near the mouths of two major tributaries to Sweetwater River is classified MRZ-4 due to lack of data. The total aggregate resource in this area is 80 million tons, of which 60 million tons is sand and the remaining 20 million tons is gravel. Replenishment of aggregate material is possible in Sectors O, P, and Q from upstream sources. The Sweetwater Reservoir Dam curtails the replenishment of Sector N. The total sand and gravel reserves for the Sweetwater River amount to 35.1 milion tons of which 22.8 million tons consist of PCC quality sand and 8.5 million tons are PCC coarse material.

Sector N

Sector N is an area of about 150 acres. It is located in the lower part of the Sweetwater River Channel near the community of Sunnyside. Most of the sector is occupied by an inactive sand quarry located upstream from the Chula Vista golf coarse. The County of San Diego has condemned this property in order to build a regional park. Consequently, mining ceased in 1980. Well logs indicate that sand in this area extends to depths of at least 60 feet. The deposit is almost entirely sand. The average waste factor which was used for resource determination in Sector N is 25 percent. The density of the sand is estimated to be 0.055 tons per cubic foot. There are no sand and gravel companies presently operating within this sector and there are no reserves. Resources for Sector N amount to 10 million tons of sand. Very little coarse material exists within the sector.

Sector O

Sector O encompasses an area of about 183 acres upstream of Sweetwater Reservoir between the highwater mark of the lake and the narrow part of the channel. The thickness of alluvial material under Sector O is about 15 feet. The Nelson Sloan Company is operating a sand pit in Sector O. The calculated remaining resource is less than 20 million tons, of which 70 percent consists of sand and 30 percent of gravel. The density of aggregate material within Sector O is estimated to be .055 tons per cubic foot. The average waste factor used for resource calculations is 25 percent.

Sector P

Sector P is situated near the upper end of the Sweetwater River channel and covers about 343 acres. The alluvial sand in this portion of the river channel is about 60 feet thick. Using a density of 0.055 tons per cubic foot and a waste factor of 20 percent (data obtained from nearby producers), a total resource of 30 million tons is calculated for this sector, of which 20 million tons are sand and 10 million tons consist of gravel. Reserves for the area are confidential. Taylor Trucking and Materials Company is the only company operating in this sector.

Sector Q

Sector Q encompasses 400 acres of alluvium in the upper end of the Sweetwater River channel, all of which is owned by the Sloan Canyon Sand Company. The alluvium is about 60 feet thick according to drill hole logs within the area and the density is about .055 tons per cubic foot. The waste is low in this section of the stream bed, a reported 10 percent. The resource and reserve figures for this sector are confidential.

OTAY VALLEY

The Otay Valley area encompasses an area of 3,193 acres. It has been a major source of aggregate production for the south San Diego County area in the past, but at present only the Nelson Sloan Company is continuing to mine sand and gravel in the eastern part of Otay Valley. Three different types of deposits, suitable as sources of PCC aggregate, are within the Otay Valley area (Plate 36). The alluvial plain of the Otay River and the terrace deposits marginal to the valley are the sources of past and present production (Sector R). A mass of metavolcanic rock in Rock Mountain (Sector S) and the San Diego Formation on the southside of Otay Valley (Sector T) are also suitable for use as PCC aggregate. Sand reserves in this area total 150 million tons, whereas the total gravel resources amount to 280 million tons. Gravel reserves for the Otay Valley are estimated at 32.5 million tons and sand reserves at 0.7 million tons.

Sector R

This sector encloses an area of 2,727 acres in which the alluvial fill in Otay Valley has been mined to a depth of about 15 feet over most of the entire area. The Nelson Sloan Sand and Gravel Company is currently operating in this sector. Drill log records for the lower end of the valley indicate an average thickness of 70 feet of economic material in that area and it can reasonably be assumed that the thickness and quality of material would be the same throughout the length of the valley, based on comparisons with other similar alluvial valleys in San Diego County. A clay layer, which has been reported by aggregate operators in the valley to lie at a depth of about 15 feet, has not been detected in the few drill logs available for this area; but the stripping o any such clay layer to expose the underlying material woul likely be economically feasible. Assuming a clay layer of 5-foo thickness, with an underlying 50 feet of alluvium, the total re source for Sector R amounts to 100 million tons of PCC qualit sand and 70 million tons of PCC quality gravel. This includes th reserves above the clay layer in the east end of the valley. A wast factor of 40 percent and a density of .065 tons per cubic foot wer used in the resource calculations. Replenishment in Otay Valle is only possible from local tributaries as the lower Otay Reser voir Dam stops any transport of sediment from upstream.

Sector S

Sector S encompasses a 360-acre mass of metavolcanic roc known as Rock Mountain, which is situated along the north sid of Otay Valley. These volcanics belong to a group of rocks calle the Santiago Peak Volcanics. The entire sector is held by th Nelson Sloan Company for aggregate mining purposes. Th metavolcanic material has an average density of about .090 ton per cubic foot with a waste factor of 5 percent. The total aggre gate resource in Sector S, allowing for final cut slopes at 1:1 an no excavation below drainage level, is 250 million tons. Usin normal crushing operations, about 50 million tons of this re source would be recoverable as sand and 200 million tons a gravel.

Sector T

The conglomeratic facies of the San Diego Formation has bee mined for coarse material along the south side of Otay Valle and near the international border. Sector T encloses an area c about 106 acres underlain by this conglomerate, that has nc been developed. Data provided by producers indicate that th density of the San Diego Formation is .070 tons per cubic foc and the waste factor is about 35 percent. The total resource i this sector is estimated at 10 million tons, all of which is grave There are no reserves in Sector T.

TIJUANA RIVER

Sector U

The floodplain of the Tijuana River extends from the interna tional border to the sea, a distance of about 5 miles. The recer floodplain is from one to two miles wide and underlain to a dept of 90 feet by alluvium composed chiefly of sand. The western most 1 1/2 miles of alluvial material within the Tijuana Rive is too fine to be used as PCC aggregate. Sector U encompasse the remaining portion of the Tijuana River floodplain to the eas an area of 2,197 acres. Two companies, Nelson Sloan and Fer ton, presently have control of two parcels of land within th Tijuana River bed. Data provided by both of these companie indicates that the density of the deposit is .055 tons per cubic foc and the waste factor is about 10 percent. The calculated resourc for this area totals 400 million tons, most of which is sanc Replenishment of the sand is possible during periods of floodin but such replenishment cannot be quantified without additiona data.

BORDER HIGHLANDS

Sector V

The hills south of the Tijuana River are known as the bord Highlands. The uppermost sedimentary unit that forms the

ıills is the conglomerate member of the San Diego Formation. The total area underlain by this unit here is about 475 acres, most of which is presently owned by the Fenton, Conrock, and Nelson Sloan sand and gravel companies. The conglomerate unit is capped by a thin terrace deposit known as the Lindavista Formation, which by itself is not economical to mine as aggregate. The conglomerate part of the San Diego Formation underlying the Lindavista Formation is up to 200 feet thick. Data from the producers in this sector give a density figure of .070 tons per cubic foot and a waste factor of 35 percent. Recent studies made by the Conrock Company (New Horizons, 1980) indicate that a portion of this 35 percent waste might be usable for the production of PCC sand. Further testing is necessary to determine what percent of the sand would be suitable. The use of this material for PCC sand would require some additional processing and thus would add to the cost of the product. The total resource in Sector V is 120 million tons, all of which is coarse PCC material.

Summary of Resources for Sectors A-V

Sectors A-V cover a total area of over 60,000 acres (about 100 square miles). The total aggregate resource contained in Sectors A-V amount to 11,000 million tons. Of this total resource, 3,100 million tons are believed to be acceptable for use as PCC quality sand, and the remaining resource, 7,800 million tons, consists of coarse PCC aggregate material.

Total aggregate reserves (resources which are currently available and under permit) for Sectors A-V amount to 430 million tons, of which only 150 million tons consist of PCC quality sand and 240 million tons consist of coarse aggregate material suitable for PCC quality gravel. The remaining 40 million tons of aggregate reserves are suitable for uses other than PCC grade material such as asphalt concrete and base. A portion of this 40 million tons could be used for PCC aggregate if additional processing of material were to take place.

Evaluation of Aggregate Consumption to the Year 2030

The total projected consumption of construction aggregate in the Western San Diego County P-C Region during the next 50 years was estimated by using industry production records and population data to obtain a tentative per-capita consumption rate. A discussion of the methodology employed follows.

50 YEAR FORECAST METHODOLOGY

To evaluate the demand of aggregate for the Western San Diego County P-C Region, an estimate was made of the total quantity of sand and gravel which would be needed to supply the region for the next 50 years (a 50-year time span is specified in the "Guidelines for Classification and Designation of Mineral Lands"). This 50-year consumption estimate was determined by using historical production (sales) records (provided by aggregate producing companies and compiled annually by the U.S. Bureau of Mines) and population data to obtain a projected per capita consumption rate. It should be noted that for the purposes of this study, the amount of aggregate produced in any one year is assumed to be equal to the amount of aggregate which is consumed in any one year. This assumption is made because production records in almost all cases are actually sales records. Consequently, production (sales) tonnage values should be identical to consumption values. It was determined that no significant import or export of material from the P-C region is taking place.

Aggregate Consumption Indicators

Factors such as the number of new residential and non-residential building permits issued, miles of new highway constructed, number of nonagricultural employees, and population data were compared with aggregate production records to determine whether or not they bore a direct relationship to the aggregate consumed in a P-C region. Simple linear regression analyses showed that population is the only factor that correlates closely with the amount of aggregate consumed in a given P-C region.

Historical Production and Population Records

Population records were compiled and correlated with aggregate production records for the period of 1960-1979 (see Figure 10). Annual aggregate production data were obtained from the U.S. Bureau of Mines, which lists statistical production information for each producer on an annual basis for all mineral commodities produced in the United States. These statistics date back to 1905, but because pre-1960 sand and gravel records for San Diego County are incomplete, they were not used for data analysis. In order to obtain a smoother curve, a three year running average was used for production data points shown on Figure 10.

Population data was obtained from California Department of Finance (1969), and California Department of Finance (1977a) for the years 1960-1975, and from San Diego County's County Data Base for the years 1975-1980.

Historical Per-Capita Consumption Rates

The Western San Diego County P-C Region had an average per-capita consumption rate of 5.5 tons of total aggregate per year over a 19-year period from 1960-1979 (Figure 11). Due to the erratic yearly aggregate production, a three-year moving average of the annual aggregate production was used in conjunction with annual population figures to compute the per-capita rates for the P-C region.

Projected Population and Per-Capita Consumption to the Year 2030

Simple linear regression analysis of historical data was conducted to evaluate basic trends in the per capita consumption rates for various P-C regions within the Los Angeles area. (Refer to San Fernando Study, Special Report 143, Part III, as a model.) These studies showed that a high per-capita consumption rate is characteristic of an overall low population density and a high rate of urban development. This high consumption rate will probably be maintained until growth rates decline with the onset of urban maturity, at which time the per-capita consumption will usually decrease, eventually leveling off to a general maintenance level.

The above discussion points out the general relationships that exist between population rates and the consumption of aggregate. On the basis of that relation, it is possible to make yearly forecasts of the total amount of aggregate that will be required to fill the needs of the Western San Diego P-C Region to the year 2030. However, it is very difficult to forecast variances in annual growth rates and accompanying changes in per-capita consumption rates into the future. Population projections are normally calculated on the basis of relatively steady growth rates which

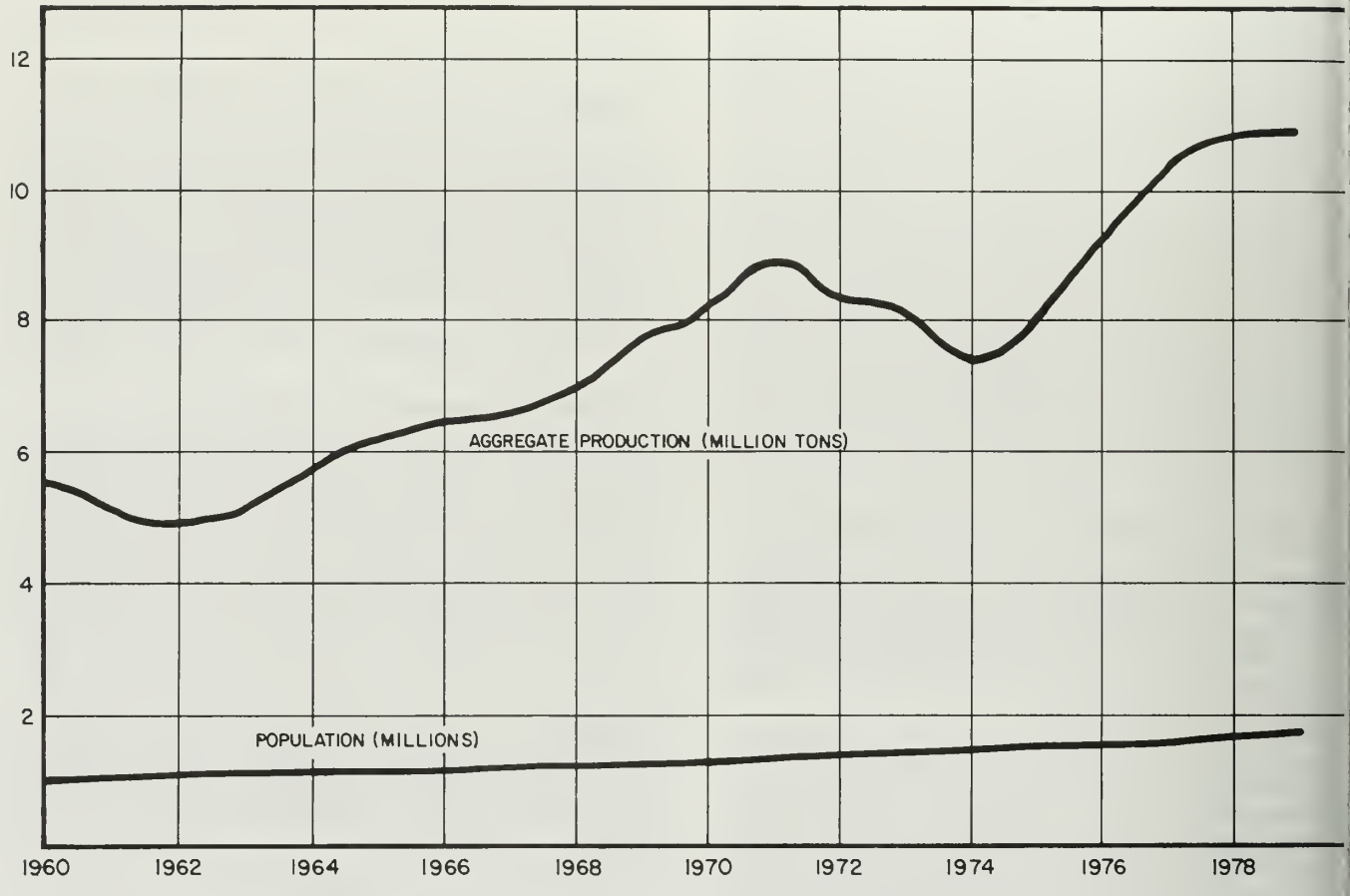

Figure 10. Papulatian and aggregate productian recard af the Western San Diego Caunty P-C Region far the years 1960-1979.

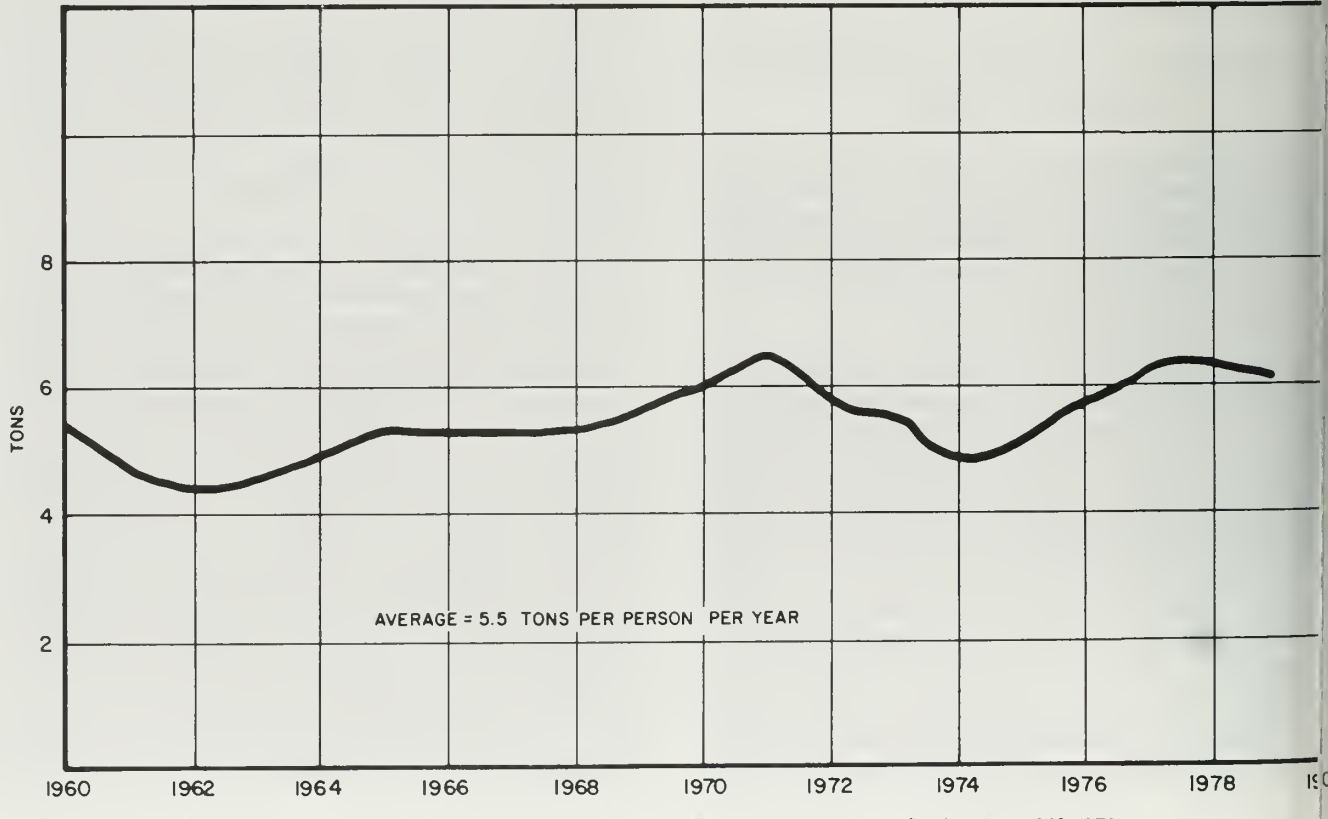

Figure 11. Annual per-capita cansumptian af aggregate in the Western San Diega Caunty P-C Regian far the years 1960-1979.

will have the effect of averaging out the future variances in the annual population. Accordingly, total aggregate needs of the Western San Diego County P-C Region to the year 2030 were calculated on the basis of two factors: (1) a projected annual per-capita aggregate consumption rate of 5.5 tons; and (2) the projected population growth for the region over the 50-year period. The results of these calculations are presented on Table 3.

Population projections for the years 1980-2020 (Figure 12) were obtained from California Department of Finance (1977b).

Table 3. Projected aggregate consumption to the year 2030 for the Western San Diego County P-C Region.

WESTERN SAN DIEGO COUNTY P-C REGION
5 yr per-capito consumption = 27.0 tons/person
(one yeor per-capito consumption = 5.5 tons/person)

YEARS	*AVERAGE POPULATION (Millions)	AGGREGATE CONSUMPTION ALL AGGREGATE (Million tons)	AGGREGATE CONSUMPTION PCC AGGREGATE (Million tons)
1980 - 1985	1.91	51.6	24.7
1985 - 1990	2.14	57.8	27.7
1990 - 1995	2.36	63.7	30.6
1995 - 2000	2.55	68.9	33.1
2000 - 2005	2.73	73.7	35.4
2005 - 2010	2.91	78.6	37.7
2010 - 2015	3.10	83.7	40.2
2015 - 2020	3.28	88.6	42.5
2020 - 2025	3.45	93.1	44.7
2025 - 2030	3.62	97.7	46.9
TOTAL ALL AGGREGATE (rounded to neorest 10 million)		760	
TOTAL PCC AGGREGATE (rounded to neorest 10 million)			360**

* Population projections for the years 1980-2000 were obtained from the California Department of Finance Report 77-P-3. Population projections for the years 2020-2030 were projected by CDMG staff from data in Report 77-P-3.

** Approximately 48 percent of the total aggregate consumed is PCC quality.

Similar population projections for the years 1985-2000 were obtained from the San Diego Association of Governments (1981) Series V Regional Growth Forecast. The projections made by the San Diego Association of Governments were consistantly below those of the Department of Finance and predicted a slightly slower growth rate. Both data sets were extrapolated on a straight-line basis by CDMG staff to the year 2030 to provide the 50-year projection specified in the SMARA Guidelines. This analysis indicates the population of the Western San Diego County P-C Region in the year 2030 will be approximately 3.6 million people (San Diego Association of Governments, 1981) or 3.7 million people (Department of Finance, 1977b). No attempt has been made to determine the most correct projection since the difference between the two, less than 3 percent, is probably not significant in extrapolations of this length. Additionally, because the SMARA classification reports are required to be updated and revised every 10 years, any disparities between actual and projected population will be accommodated at that time.

Because there was only a slight difference between both data sets and because the Department of Finance data required only a staff extrapolation of 10 years beyond the published projection (as opposed to 30 years with the San Diego Association of Governments data), the data set from the Department of Finance was selected for use in this report.

When the 19-year historical average per-capita rate (Figure 11) is combined with population projections for the Western San Diego County (Figure 12) the total aggregate consumption need to the year 2030 is estimated to be 760 million tons, of which 360 million tons should be of PCC quality.

FACTORS AFFECTING PER-CAPITA CONSUMPTION RATES

The annual per-capita consumption rates within the Western San Diego County P-C Region show considerable variation (see Figure 11). Factors such as changes in urban growth with time, relative degrees of urban maturity, and major construction projects (for example, freeways) could account for many of these variations.

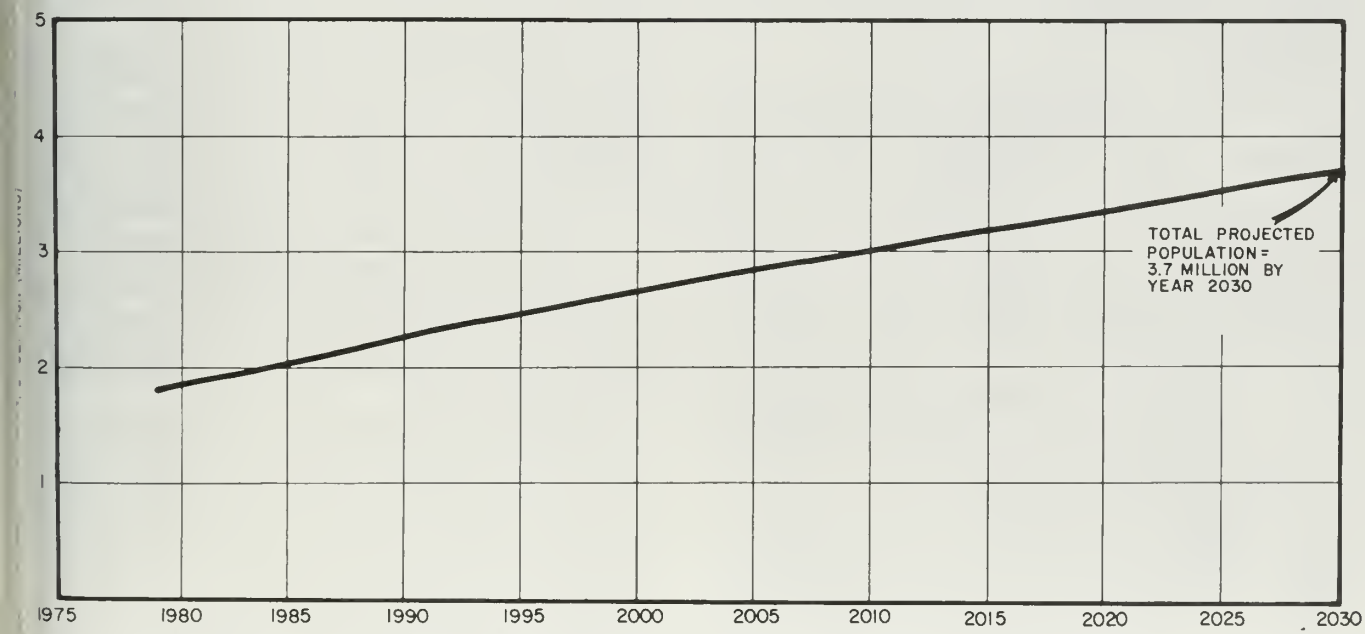

Figure 12. Projected populotion of the Western Son Diego P-C Region to the yeor 2030. (Doto from Stote Deportment of Finance).

The average Western San Diego County P-C Region per capita consumption rate of 5.5 is believed valid for forecasting future needs unless unforeseen events occur, such as massive urban renewal or disaster reconstruction. The average per-capita consumption rate over the next 50-year period in the Western San Diego County P-C Region could increase considerably as a result of extensive earthquake damage or other unforeseen circumstances that would necessitate massive reconstruction. Such events would result in a sharp increase in per capita consumption of aggregate during the period of active reconstruction. The amount of aggregate needed in addition to the steady state consumption of 5.5 tons per person per year would depend upon the extent and duration of reconstruction. Per-capita consumption would probably then gradually return to an annual rate equivalent to that which existed before reconstruction began.

Aggregate Resource Distribution and Haulage Cost

A large portion of the cost of sand and gravel to the consumer is attributed to transportation. Comparison of Table 2 with the appropriate sector map shows that coarse PCC aggregate reserves (material not passing # 4 mesh) are fairly evenly distributed throughout the Western San Diego County P-C Region. Conversely, sand reserves are very unevenly distributed with approximately 70 percent of all PCC quality sand reserves contained within the San Luis Rey River, located in the northern portion of the P-C region.

Table 4 shows various hauling charges from selected sand production areas in western San Diego's six major river basins to two centrally located delivery points A and B (Figure 13). These rates were taken from the State Public Utilities Commission (minimum Rate Tariff 17-A, rates as of November 18, 1979). The San Marcos location (delivery point B) was chosen as a central delivery point expected to be served from the northern portion of the Western San Diego P-C Region. The intersection of Highway 163 and Interstate 8 (delivery point A) was chosen as a central delivery locality expected to be served from the southern portion of the Western San Diego County P-C Region. These haulage cost figures emphasize the additional cost that transportation has on the cost of aggregate to the consumer. An example of this additional cost can be seen when comparing the cost of transporting material from Pala (a production area from the San Luis Rey River) to delivery point A, with the cost of transporting material from Lakeside (a production area from the upper San Diego River) to delivery point A. The former haulage cost amounts to $4.89/ton and the latter haulage cost is $1.81/ton. Thus, considering that the cost per ton of sand roughly averages $4.00 at the plant, sand transported from Pala to delivery point A will have a 65 percent higher cost than a ton of sand transported from the Lakeside area to the same point

Table 4. Haulage charges as of November 18, 1979, from selected sand production areas to delivery point A (Interstate 8 and State Route 163) and delivery point B (City of San Marcos).

RIVER BASIN	PRODUCTION AREA LOCATION	HAULING CHARGE PER TON TO DELIVERY ZONE A (Interstate 8 and State Route 163)	HAULING CHARGE PER TON TO DELIVERY ZONE B (San Marcos)
San Luis Rey	Oceanside	not hauled	1.72
	Pala	4.89	2.67
San Dieguito	Lake Hodges	2.55	1.70
	San Pasqual	2.97	1.96
San Diego	San Vicente Dam Junction	2.24	3.17
	Lakeside	1.81	3.52
	Grantville	.76	3.09
	Mission Valley	.64	3.07
Sweetwater	Jamacha	1.83	not hauled
	Dehesa	2.15	4.48
Otay	Otay	1.71	not hauled
Tia Juana	San Ysidro	1.90	not hauled

Note: All rates are taken from State Public Utilities Commission Minimum Rate Tariff 17-A.

Comparison of the 50-Year Aggregate Demand with Current Reserves

Based upon an average per capita consumption rate of 5.5 tons per person over the last 20 years, and a projected population of 3.7 million, a total of 760 million tons of aggregate will be needed to supply the Western San Diego County P-C Region for the next 50 years. The total aggregate reserve for the Western San Diego P-C Region is approximately 430 million tons, an amount which is sufficient to supply the P-C region for the next 32 years (see Table 3, page 23). This leaves a 330 million ton deficit of aggregate to supply the entire Western San Diego P-C Region to the year 2030.

Future aggregate must contain sufficient suitable material for use in Portland cement concrete (PCC). According to the U.S. Bureau of Mines production data for the period 1951-1978, an average of 48 percent of the total aggregate consumed annually within San Diego County was used in Portland cement concrete. Of this, crushed stone comprises a very small percentage. If it is assumed that this historic percentage of PCC material used remains the same to the year 2030, then the total amount of PCC aggregate needed to supply the Western San Diego County P-C Region to the year 2030 is 360 million tons.

It is estimated that 390 million tons of the total reserves for the Western San Diego County P-C Region are suitable for use in PCC aggregate. Approximately 240 million tons of this PCC aggregate material consist of gravel sized material while only 150 million tons is sand. Because the standard PCC aggregate material is made up of almost equal mixtures of sand and gravel and there are only 150 million tons of sand reserves, then the total PCC aggregate reserves are limited to approximately 300 million tons (double the sand reserve quantity).

Based upon a total projected PCC aggregate demand of 360 million tons and assuming that all PCC quality material will also be used for PCC aggregate, total PCC aggregate reserves is limited to approximately 300 million tons (double the sand reserve quantity).

Based upon a total projected PCC aggregate demand of 360 million tons and assuming that all PCC quality material will also be used for PCC aggregate, there is an anticipated 60 million ton deficit of PCC aggregate for the next 50 years. However, historical and present studies of aggregate use in the Western San Diego P-C Region has shown that a large quantity of PCC quality aggregate is used for other purposes such as asphalt concrete base, and various other lower quality aggregate uses. Assuming that future aggregate PCC material continues to be used for

gure 13. Map showing delivery paint A (Intersection af Interstate 8 and State Raute 163) and delivery point B (City af San Marcas).

lower grade aggregate purposes, this 60 million ton deficit could easily become much greater. It should be noted that the PCC aggregate resource quantity could be sizably increased if crushing of coarse material to sand-size material takes place. Such crushing would be quite costly and would not likely take place unless all close-by natural sand resources are unavailable.

ALTERNATIVE SOURCES OF AGGREGATE

Potential sources of aggregate, in addition to the deposits classified as MRZ-2 (Resource sectors A-V), are within and near the Western San Diego County P-C Region. These potential sources include granitic and gabbroic rocks, metavolcanic rocks, recent offshore deposits, and alluvium in river channels. The Orange County P-C Region to the north, which is the closest major P-C region, is too distant to be considered as a possible alternative source of aggregate except to provide small amounts to the northernmost communities.

Too little is known about the alternative sources within and near the Western San Diego County P-C Region to allow any but the crudest resource estimates to be made. A general discussion about the occurrence and factors controlling the utilization of alternative sources of aggregate is presented.

Crushed Rock Sources

Metavolcanic rocks of the Santiago Peak Volcanics and crystalline basement rocks of the Southern California Batholith crop out throughout most of San Diego County. These rocks may become an important PCC aggregate source in the future.

METAVOLCANIC ROCKS (SANTIAGO PEAK VOLCANICS)

Metavolcanic rock of the Santiago Peak Volcanics is exposed near the eastern edge of the study area, roughly separating the sedimentary coastal plain to the west from the crystalline granitic terrain to the east (Figure 7). These rocks are discussed in more detail on page 12 .

Although a significant portion of the study area is underlain by Santiago Peak Volcanics, mining of suitable concrete aggregate material is limited to only a few locations. Aggregate products mined from the metavolcanic rocks are coarse concrete aggregate, asphaltic aggregate, road base, and other rock products. No sand is being produced at present. Deposits presently being mined typically contain very little waste, generally less than five percent. Overburden ranges from zero to 25 feet and typically consists of a residual soil and weathered rock mantle. Traces of pyrite have been noted in this formation and could result in higher waste percentages locally. Typically, the formation below the weathered zone is hard and durable without chemically reactive deleterious material. From a geologic standpoint, the depth of this formation is not known. The depth to the ground water table will probably place a practical limit on the mineable depth.

Drill logs and test data are lacking for much of the area. Where the formation is mapped, no test data is available to determine the quality of the material; these areas are therefore classified MRZ-3. Several billion tons could be available for possible future use as aggregate in the Western San Diego County P-C Region if the rock quality proves to be acceptable.

GRANITIC ROCKS

Much of San Diego County is underlain by granitic rock including the eastern part of the study area (Figure 7). Graniti rocks form mountainous regions from within a few miles of th coast to Borrego Valley. These rocks are discussed in more deta on page 8 , "Areas Classified MRZ-2."

Numerous small quarries are scattered throughout these gr nitic rocks. Most of the quarries mine fresh granitic rock whic is used for riprap, dimension stone, roofing granules, and decor tive rock. Very little granitic rock has been used for concre aggregate although it is possible that much of the fresh graniti rock would be acceptable for use in PCC aggregate. Testing don by the property owner of aggregate material from two quarrie one inactive quarry in the the city of San Marcos, and anothe active quarry in the vicinity of Vista, has shown that the materi from these quarries meets the specifications for PCC aggregat Both of these areas are classified as MRZ-2. Because the graniti rocks are not known to be homogenious in the region, and ma therefore be of variable quality from site to site, more test info mation is necessary before large regions of basement rock can b zoned MRZ-2. Little waste is generally expected from the mi ing of fresh rock; however, some areas reportedly have extensiv overburden of weathered material (Weber, 1963). Weber r ports some areas underlain by tonalite having a mantle of weat ered material from 10 to 100 feet thick.

Granitic areas where test data does not exist, including exis ing riprap and dimension stone quarries, are classified as MRZ 3. Additional information could very likely indicate that the areas contain high quality PCC aggregate material. It is highl probable that these granitics could provide an alternative aggr gate source for the Western San Diego County P-C Region in th future.

Sedimentary Rocks

The Late Mesozoic and Cenozoic sedimentary rocks in t study area contains an abundance of coarse-grained formatio (Figure 7). Several of these are now being used or have be used in the past as sources of construction aggregate. Tho formations, or parts of formations for which there is sufficie test data available to demonstrate their suitability for use as PC aggregate, have been classified as MRZ-2. The remainder of t sedimentary units that are composed of sand or coarser materi are classified as MRZ-3 (see page 14 for discussion of these unit All of these units may contain deposits suitable for use in PC aggregate yet some are not considered as likely, alternati sources of aggregate because they already have land uses incor patible with mining (see page 40, California State Mining a Geology Board, 1979). Also, units that have very limited are extent and thickness are not likely candidates for alternati aggregate sources because of the limited volume of accessib aggregate they contain. Keeping these limitations in mind, t units most likely to be potential sources of aggregate are t Torrey Sandstone and the Scripps Formation, both in the Eoce La Jolla Group; the Mission Valley Formation of the Eoce Poway Group; the Miocene San Onofre breccia; the Miocen Pliocene Otay Formation and an associated unnamed fanglo erate; and the San Diego (sandstone unit only), Lindavista, a Bay Point Formations of Pliocene Pleistocene age.

All of the above-mentioned units may contain potenti sources of sand. Lithologic descriptions and field observatio indicate that the most favorable units are the Torrey Sandsto the Scripps Formation, and sandstone lenses of the San Ono breccia. Less favorable sand units lie within the Mission Val Formation (western portion only), the Otay Formation, the S

Diego Formation, and the Bay Point Formation. Much of the sand in these formations would probably be too fine for use as PCC sand. Without more detailed geologic mapping and aggregate test data, no further evaluation of these areas can be made.

Coarse aggregate could likely be mined from the easternmost exposures of the Mission Valley Formation, the San Onofre breccia, and the unnamed fanglomerate near Lower Otay Reservoir.

Of special note is the San Onofre breccia exposed in the northern part of the region. For more than a decade during the 1950s and 1960s, the H.W. Rohl Company produced sand and gravel for use as concrete aggregate from the San Onofre breccia near Oceanside. Although difficulties due to the high silt content were experienced in processing the deposit, it was an economically viable operation during its lifetime.

RECENT ALLUVIAL DEPOSITS

The Tijuana River south of the international border very likely contains large amounts of unconsolidated alluvial sand which is probably suitable for use as construction aggregate. Nothing is known about the quantity or quality of this potential resource.

The Camp Pendleton Marine base north of the P-C region boundary includes several moderate-size stream channel deposits for which little data are available. Some of the alluvium in the Santa Margarita River channel and the San Marcos and San Onofre canyons may be of sufficient quality to be used as PCC aggregate.

The long coastline of the Western San Diego P-C Region is edged by beach deposits composed primarily of unconsolidated sand. No mining currently takes place in these sands, and the suitability of these deposits as an aggregate source has not been assessed. Mining of these sands would very likely be in conflict with the recreational and other uses of the beach area.

In light of the overall sand shortage in western San Diego County, a brief reconnaisance study was made to determine the presence of economic sand resources east of the P-C region. This evaluation was based on a review of geologic maps and literature, Bureau of Mines production data, lists of mineral producers in the region, and limited field work.

No sand deposits meeting standards for classification as MRZ-2 or having any production history could be found within economic distance of the eastern boundary of the P-C region. The closest sand producers to the eastern boundary of the region are in Imperial County along the ancient beach deposits bordering the Salton Trough, a distance of over 70 miles from the center of the consumption area where the sand is needed.

OFFSHORE SEDIMENT DEPOSITS

Aggregate material is being mined successfully from marine deposits offshore from the United Kingdom, Holland, the Virgin Islands, and the Bahama Islands. Several known similar deposits of coarse sand and gravel are offshore of San Diego County. Among these deposits are those along the margin of San Clemente Island and some of its banks, and a near-shore coarse-aggregate deposit in the vicinity of the Tijuana River, locally called the "Tijuana cobble patch." These two areas are described below.

San Clemente Island and Bank Areas

Numerous deposits of gravel, coarse sand, and sand have been located around the margin of San Clemente Island (Welday and Williams, 1975). Also, the undersea highs landward of San Clemente Island—which are known as Forty-mile Bank, Thirty-mile Bank, and Coronado Escarpment—are capped with extensive sand deposits and scattered patches of gravel. Neither the quantity nor quality of these deposits has been assessed, and none have been mined to date.

San Diego Shelf Near Mouth of the Tijuana River

A large deposit of coarse aggregate, locally called the "Tijuana cobble patch," lies near shore in the vicinity of the Tijuana River. Sprague (1971) has studied the character of the deposits, and Chambers Consultants and Planners (1979) have reported on the economic feasibility of mining it for sand and gravel.

Studies by Sprague indicated that the deposit averages about 5 feet in thickness over an area of approximately 3 square miles. The material is durable and relatively nonreactive and has a sand-to-gravel ratio of nearly 50:50. Sprague estimated the volume of the deposit to be about 20 million cubic yards (30 million tons). Chambers Consultants and Planners (1979) concluded that the deposit cannot be economically recovered using current seabed mining technology.

CONCLUSIONS

The total aggregate reserves for the Western San Diego Production-Consumption Region add up to 430 million tons. Approximately 90 percent (390 million tons) of these reserves are suitable for use in Portland cement concrete (PCC) products. These PCC quality aggregate reserves are divided into a PCC concrete sand category of 150 million tons and a PCC concrete coarse aggregate category of 240 million tons. Since the average sand to gravel ratio in PCC aggregate is approximately 50:50, the total PCC aggregate reserve is limited to twice the quantity of sand, which amounts to 300 million tons. It should be noted that each ton of sand that is translated into reserves will actually increase the total PCC aggregate reserves by two tons.

Based upon the projected population increase and the predicted per-capita consumption rates, approximately 760 million tons of aggregate will be needed to supply the entire Western San Diego County P-C Region to the year 2030. With a total aggregate reserve of 430 million tons, a 32-year supply, this leaves a 330 million ton deficit of aggregate to supply the Western San Diego P-C Region to the year 2030. Unforseen events in the future such as massive urban renewal or disaster reconstruction may increase this deficit.

Assuming that all PCC quality aggregate material will be used for PCC, there is expected to be an 60 million ton deficit of PCC aggregate within the next 50 years. However, if current and past practices of using PCC quality aggregate for other uses are continued, this deficit will be considerably more.

There is an uneven distribution of PCC sand reserves within the Western San Diego P-C Region. Approximately 70 percent of the current PCC sand reserves within the P-C region are located within the San Luis Rey River, which is situated in the northern part of the area. Transportation of these sand reserves to the major metropolitan and urbanizing areas of San Diego County will result in a considerable increase in the cost of aggregate to the consumer as well as adding to pollution, fuel consumption, and traffic.

Large quantities of non-permitted PCC sand resources lie within all major river drainages of the Western San Diego P-C region. Designation of all or portions of those sectors having sand resources, particularly those resource areas that are situated near areas of rapid urbanization, would help alleviate long haulages of sand from more distant resource localities.

Resources (reserves and non-permitted resources) for the Western San Diego County P-C Region amount to approximately 11,000 million tons, of which approximately 7,900 million tons consist of coarse concrete aggregate and 3,100 million tons consist of concrete sand. It should be noted that these large aggregate resource tonnage figures represent the total quantity of aggregate material that is geologically and technologically available for mining. Except for the exclusion of urbanized areas, they do not reflect such constraints to mining as current land us or political, sociological, environmental, and other factors.

Aggregate resources not currently under permit may be tran slated into reserves by (1) extending the operating life of existin operations where there are resources available beneath the per mitted depth of mining, (2) opening new operations, (3) devel oping alternate resources such as off-shore sand, and/or (4 crushing coarse material to sand-size particles.

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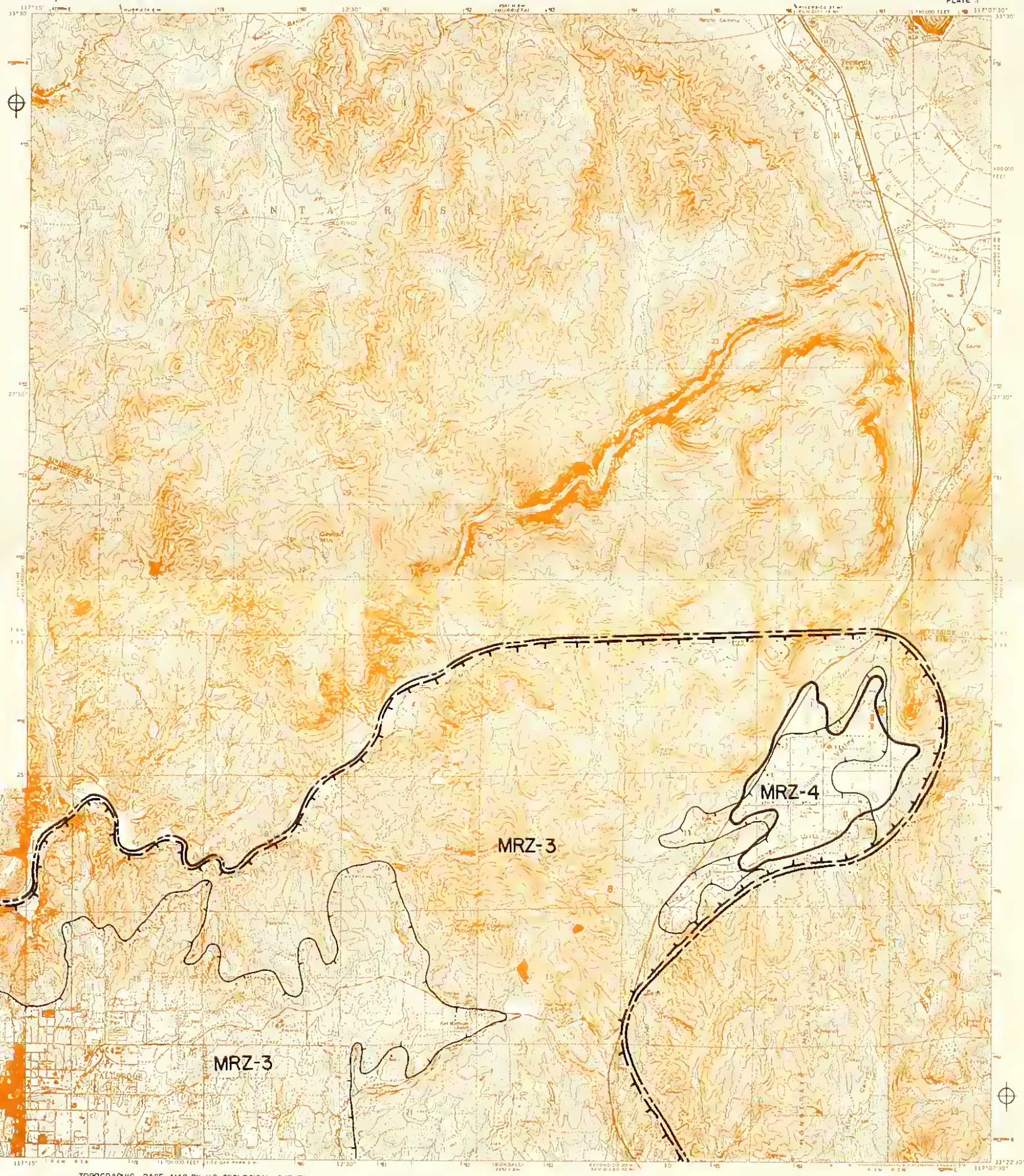
TEMECULA QUADRANGLE
SPECIAL REPORT 153
PLATE 1



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

TEMECULA, CALIF.

EXPLANATION

Drill hole

OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
Boundaries established from data supplied by the Office of Planning and Research with modifications developed from information supplied by local government and other sources. Hachures lie within area undergoing urbanization.

EXISTING URBAN BOUNDARIES
Boundaries established by the Office of Planning and Research and by data supplied by local government agencies and other sources to reflect present conditions. Hachures lie within urban area.

PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

MRZ-2

MRZ-1 Areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence.

MRZ-2 Areas where adequate information indicates that significant mineral deposits are present or where it is judged that a high likelihood for their presence exists.

MRZ-3 Areas containing mineral deposits the significance of which cannot be evaluated from available data.

MRZ-4 Areas where available information is inadequate for assignment to any other MRZ zone.

See text for additional explanation of MRZ Symbols.

MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST FEBRUARY 15 1983

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DEPARTMENT OF CONSERVATION

PECHANGA QUADRANGLE
SPECIAL REPORT 153
PLATE 2

TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

EXPLANATION

Drill hole

OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
Boundaries established from data supplied by the Office of Planning and Research with modifications developed from information supplied by local government and other sources. Hachures lie within area undergoing urbanization.

EXISTING URBAN BOUNDARIES
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PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

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See text for additional explanation of MRZ Symbols.

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

PECHANGA, CALIF.

MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

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MORRO HILL QUADRANGLE
SPECIAL REPORT 153
PLATE 3

TOPOGRAPHIC BASE MAP BY U.S GEOLOGICAL SURVEY
Reduced from 1:24,000

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

MORRO HILL, CALIF.

EXPLANATION

- Drill hole

OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
Boundaries established from data supplied by the Office of Planning and Research with modifications developed from information supplied by local government and other sources. Hachures lie within area undergoing urbanization.

EXISTING URBAN BOUNDARIES
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PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

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MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

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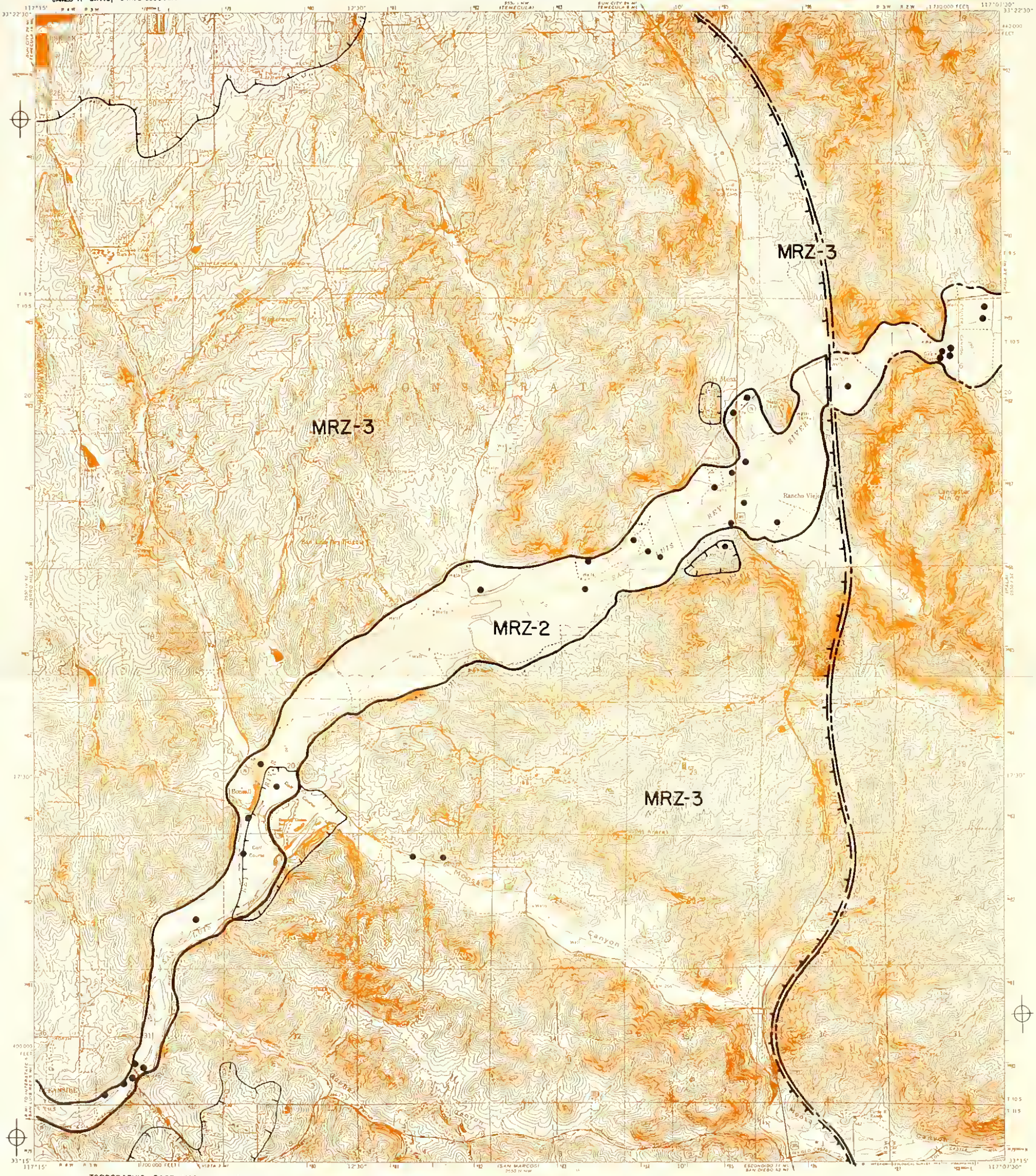
BONSALL QUADRANGLE
SPECIAL REPORT 153
PLATE 4



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

BONSALL, CALIF.

EXPLANATION

Drill hole

OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
Boundaries established from data supplied by the Office of Planning and Research with modifications developed from information supplied by local government and other sources. Hachures lie within area undergoing urbanization.

EXISTING URBAN BOUNDARIES
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PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

MRZ-2

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MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

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PALA QUADRANGLE
SPECIAL REPORT 153
PLATE 5

TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

EXPLANATION

Drill hole

OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
Boundaries established from data supplied by the Office of Planning and Research with modifications developed from information supplied by local government and other sources. Hachures lie within area undergoing urbanization.

EXISTING URBAN BOUNDARIES
Boundaries established by the Office of Planning and Research and by data supplied by local government agencies and other sources to reflect present conditions. Hachures lie within urban area

PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

MRZ-1 Areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence.

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MRZ-3 Areas containing mineral deposits the significance of which cannot be evaluated from available data.

MRZ-4 Areas where available information is inadequate for assignment to any other MRZ zone.

MRZ-2

See text for additional explanation of MRZ Symbols.

PALA, CALIF.

MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

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BOUCHER HILL QUADRANGLE
SPECIAL REPORT 153
PLATE 6

MRZ-2

MRZ-2

MRZ-2

TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

EXPLANATION

Drill hole

OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
Boundaries established from data supplied by the Office of Planning and Research with modifications developed from information supplied by local government and other sources. Hachures lie within area undergoing urbanization.

EXISTING URBAN BOUNDARIES
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PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

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MRZ-4 Areas where available information is inadequate for assignment to any other MRZ zone.

See text for additional explanation of MRZ Symbols.

CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT HALF INTERVAL CONTOURS
DATUM IS MEAN SEA LEVEL

BOUCHER HILL, CALIF.

MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

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STATE GEOLOGIST FEBRUARY 15, 1983

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STATE OF CALIFORNIA
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OCEANSIDE QUADRANGLE
SPECIAL REPORT 153
PLATE 7

TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL
DEPTH CURVES AND SOUNDINGS IN FEET—DATUM IS MEAN LOWER LOW WATER

OCEANSIDE, CALIF.

EXPLANATION

- Drill hole

OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
Boundaries established from data supplied by the Office of Planning and Research with modifications developed from information supplied by local government and other sources. Hachures lie within area undergoing urbanization.

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PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

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MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST FEBRUARY 15, 1983

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STATE OF CALIFORNIA
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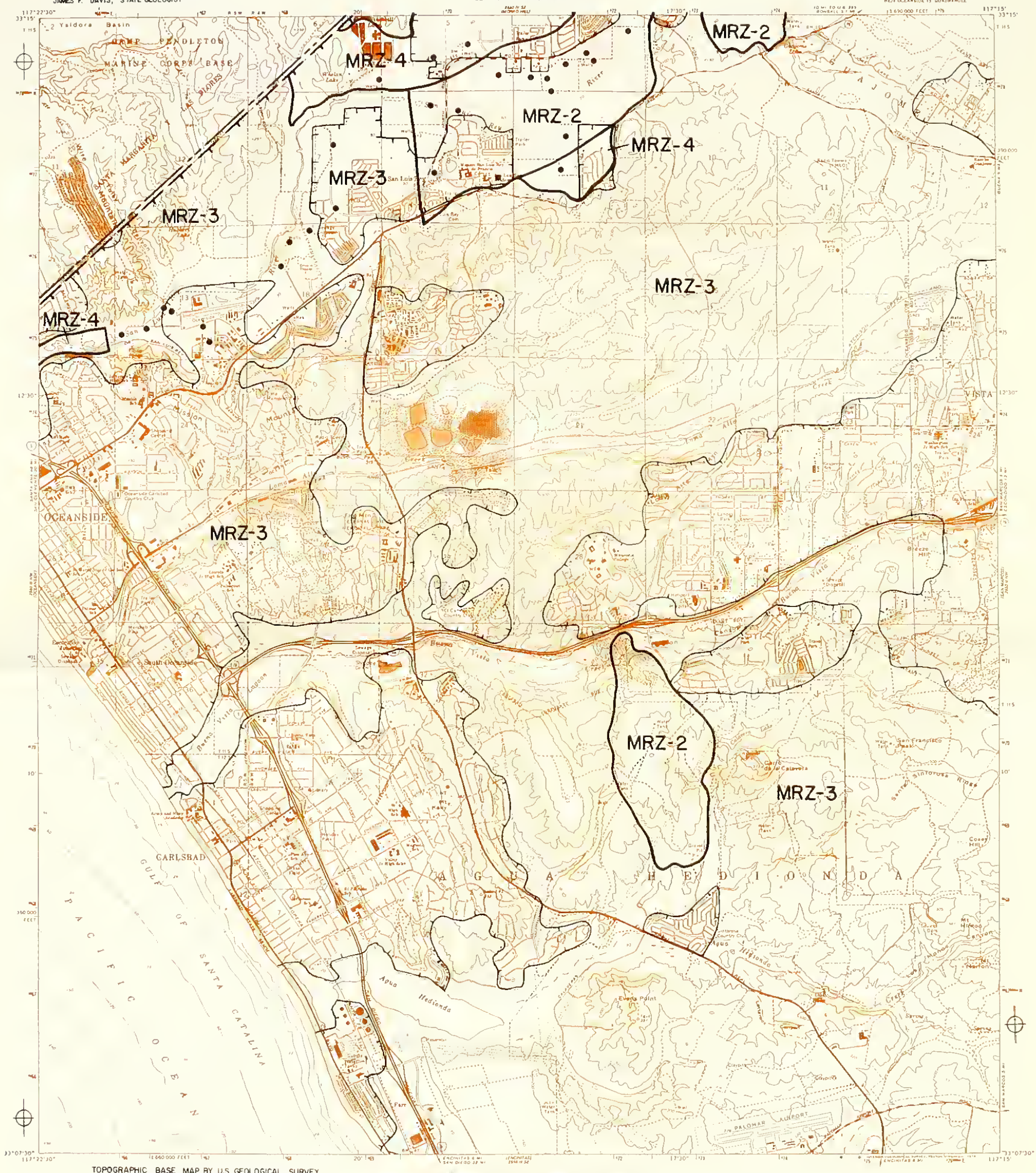
SAN LUIS REY QUADRANGLE
SPECIAL REPORT 153
PLATE 8



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10 FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929
DEPTH CURVES AND SOUNDINGS IN FEET—DATUM IS MEAN LOWER LOW WATER
SHORELINE SHOWN REPRESENTS THE APPROXIMATE LINE OF MEAN HIGH WATER
THE MEAN RANGE OF TIDE IS APPROXIMATELY 6 FEET

SAN LUIS REY, CALIF

EXPLANATION

Drill hole

OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
Boundaries established from data supplied by the Office of Planning and Research with modifications developed from information supplied by local government and other sources. Hachures lie within area undergoing urbanization.

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(see text for discussion)

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MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

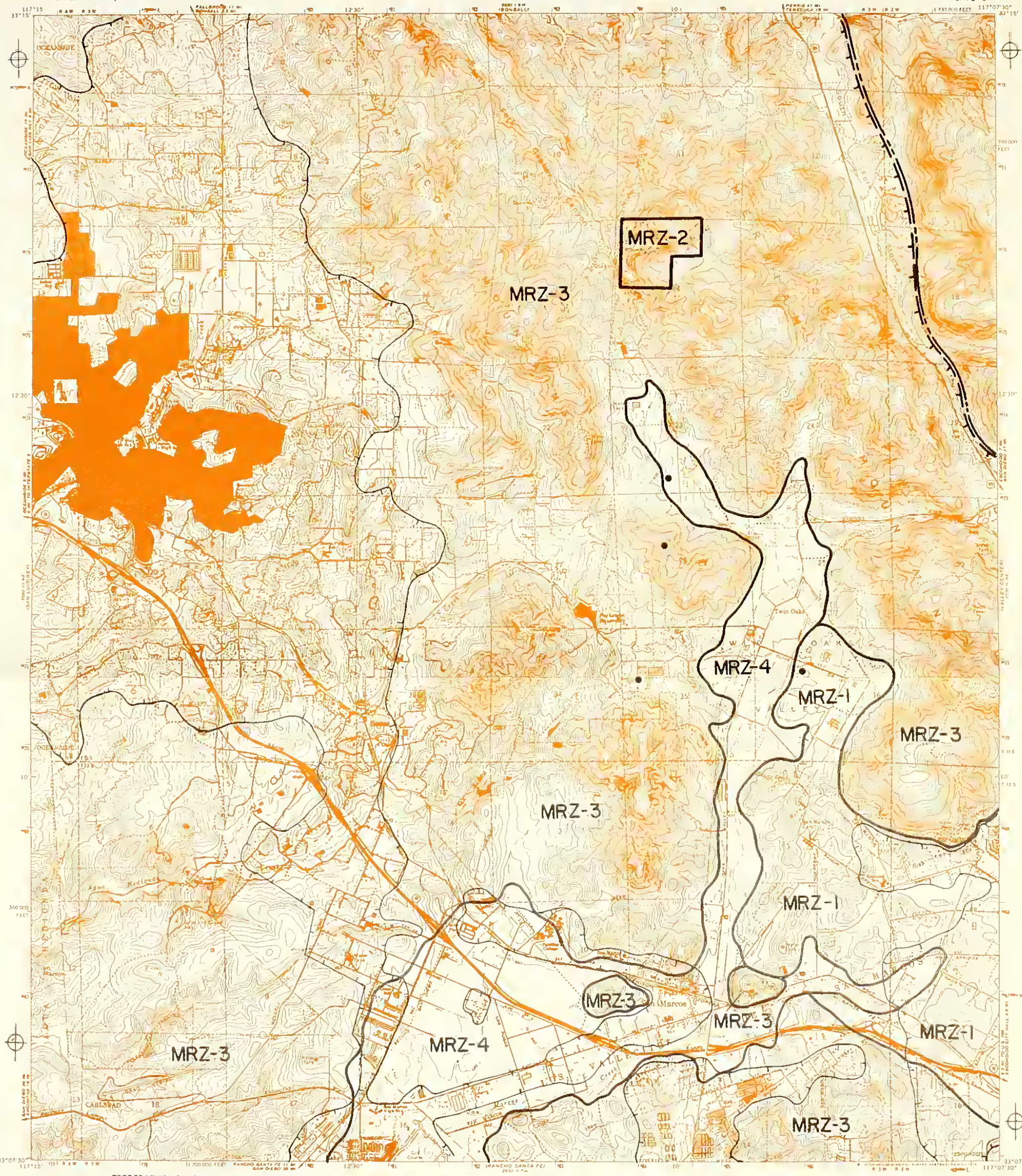
PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST FEBRUARY 15, 1983

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

SAN MARCOS QUADRANGLE
SPECIAL REPORT 153
PLATE 9



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

SAN MARCOS, CALIF.

EXPLANATION

Drill hole

OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
Boundaries established from data supplied by the Office of Planning and Research with modifications developed from information supplied by local government and other sources. Hachures lie within area undergoing urbanization.

EXISTING URBAN BOUNDARIES
Boundaries established by the Office of Planning and Research and by data supplied by local government agencies and other sources to reflect present conditions. Hachures lie within urban area.

PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

MRZ-2

- MRZ-1 Areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence.
- MRZ-2 Areas where adequate information indicates that significant mineral deposits are present or where it is judged that a high likelihood for their presence exists.
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See text for additional explanation of MRZ Symbols.

MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

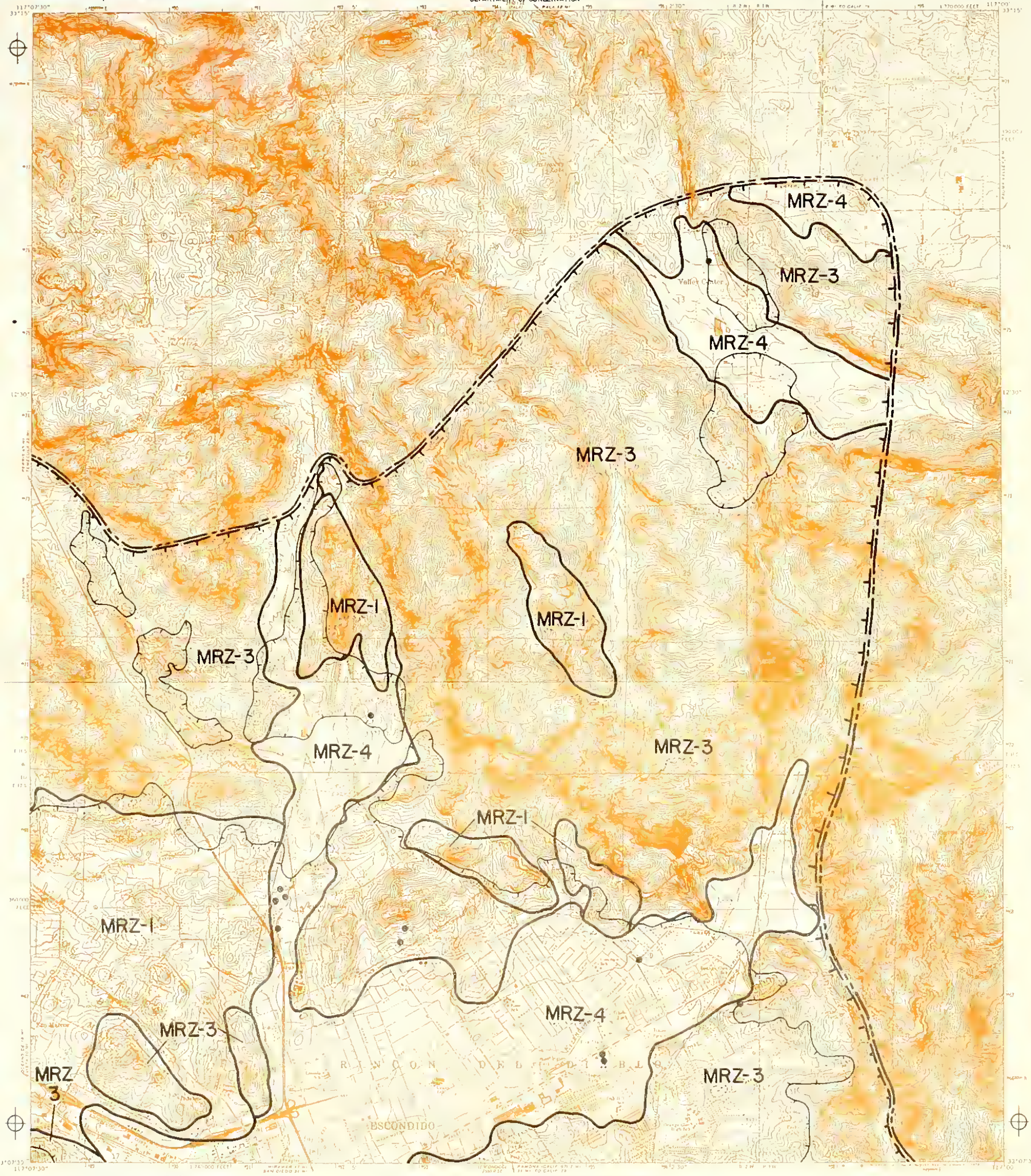
PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST FEBRUARY 15, 1983

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

VALLEY CENTER QUADRANGLE
SPECIAL REPORT 153
PLATE 10



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

VALLEY CENTER, CALIF.

EXPLANATION

Drill hole

OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
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PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

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MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

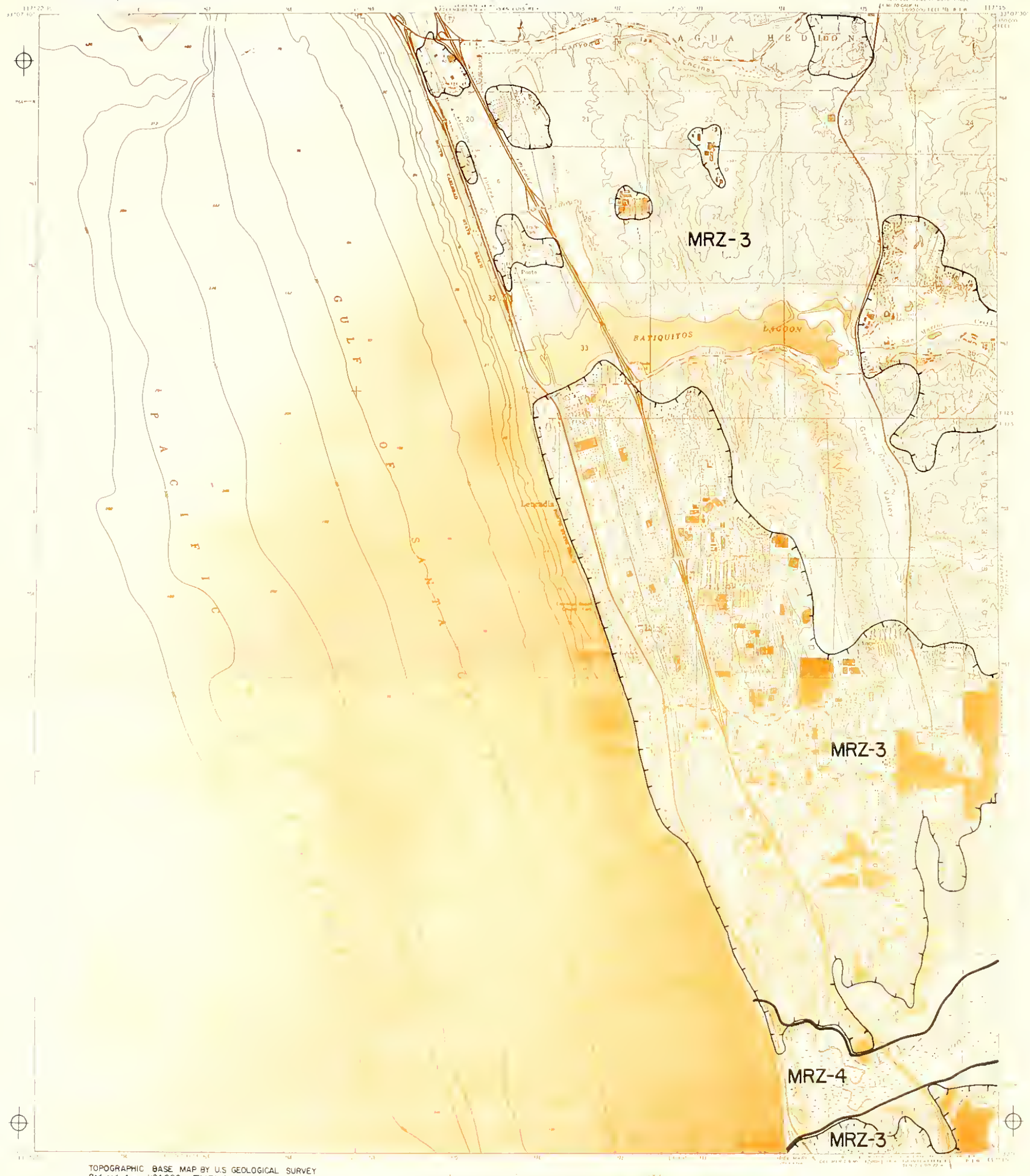
PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST FEBRUARY 15, 1983

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

ENCINITAS QUADRANGLE
SPECIAL REPORT 153
PLATE 11



TOPOGRAPHIC BASE MAP BY U.S GEOLOGICAL SURVEY
Reduced from 1:24,000

EXPLANATION

- Drill hole

OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
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PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

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ENCINITAS, CALIF

MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

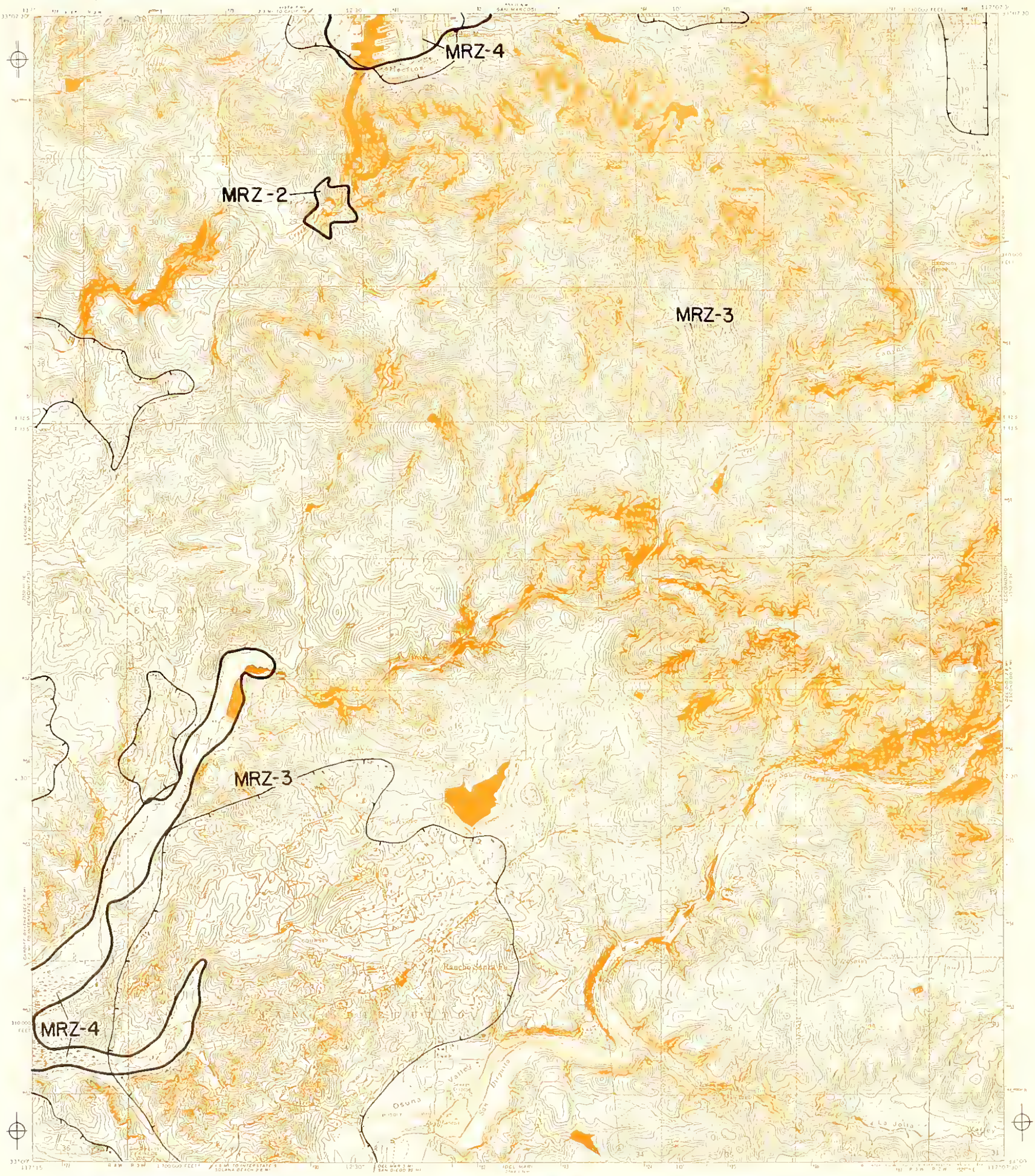
PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

STATE GEOLOGIST FEBRUARY 15, 1983

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

RANCHO SANTA FE QUADRANGLE
SPECIAL REPORT 153
PLATE 12



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10 FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

RANCHO SANTA FE, CALIF.

EXPLANATION

Drill hole

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PRODUCTION-CONSUMPTION REGION BOUNDARY
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MINERAL RESOURCE ZONE BOUNDARIES

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MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

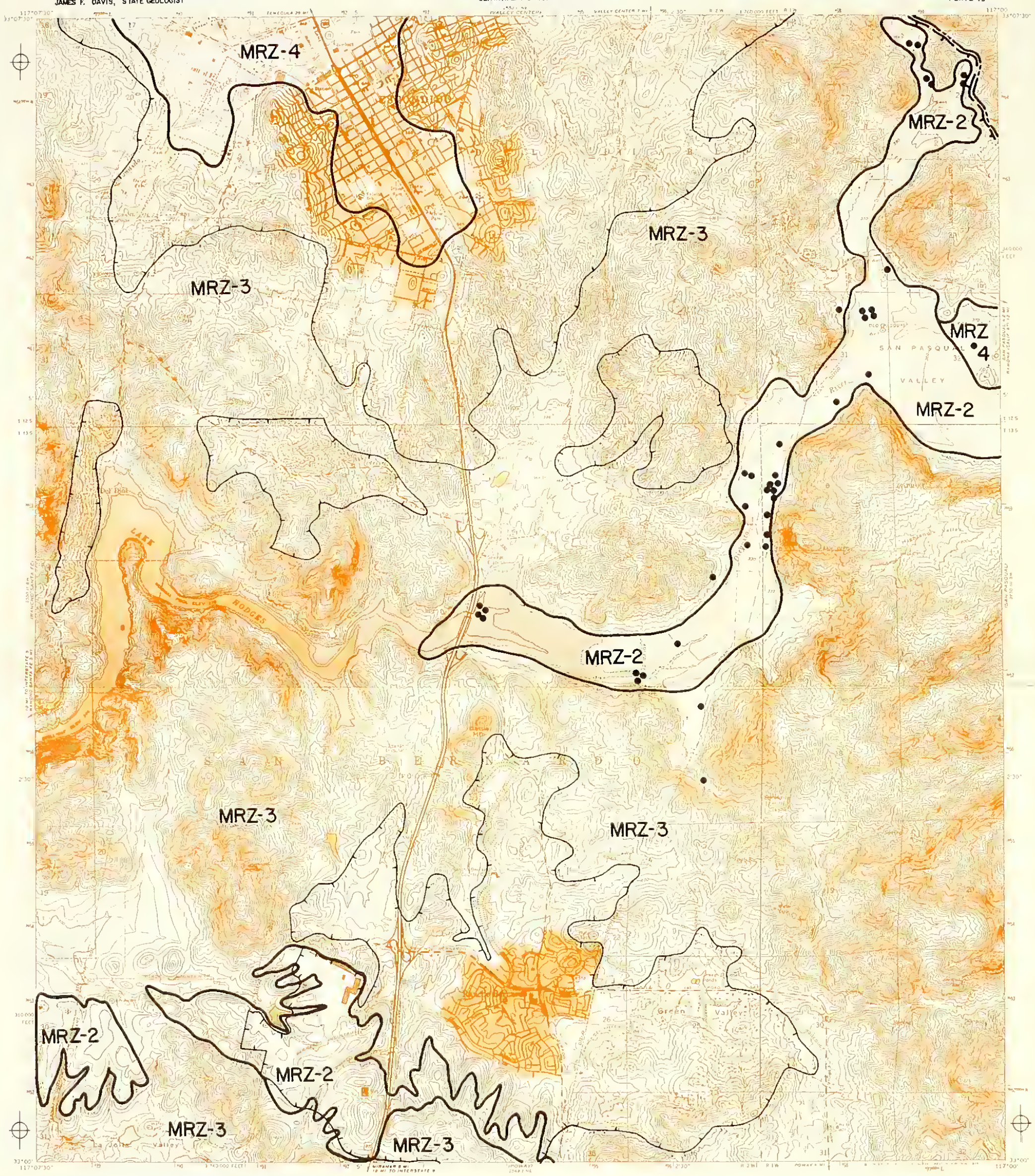
PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST FEBRUARY 15, 1983

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

ESCONDIDO QUADRANOLE
SPECIAL REPORT 153
PLATE 13



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

ESCONDIDO, CALIF.

EXPLANATION

- Drill hole

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PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

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MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST FEBRUARY 15, 1983

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

SAN PASQUAL QUADRANGLE
SPECIAL REPORT 153
PLATE 14

MRZ-3
MRZ-4
MRZ-2
MRZ-3
MRZ-3

TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

EXPLANATION

Drill hole

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PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

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See text for additional explanation of MRZ Symbols.

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

SAN PASQUAL, CALIF.

MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

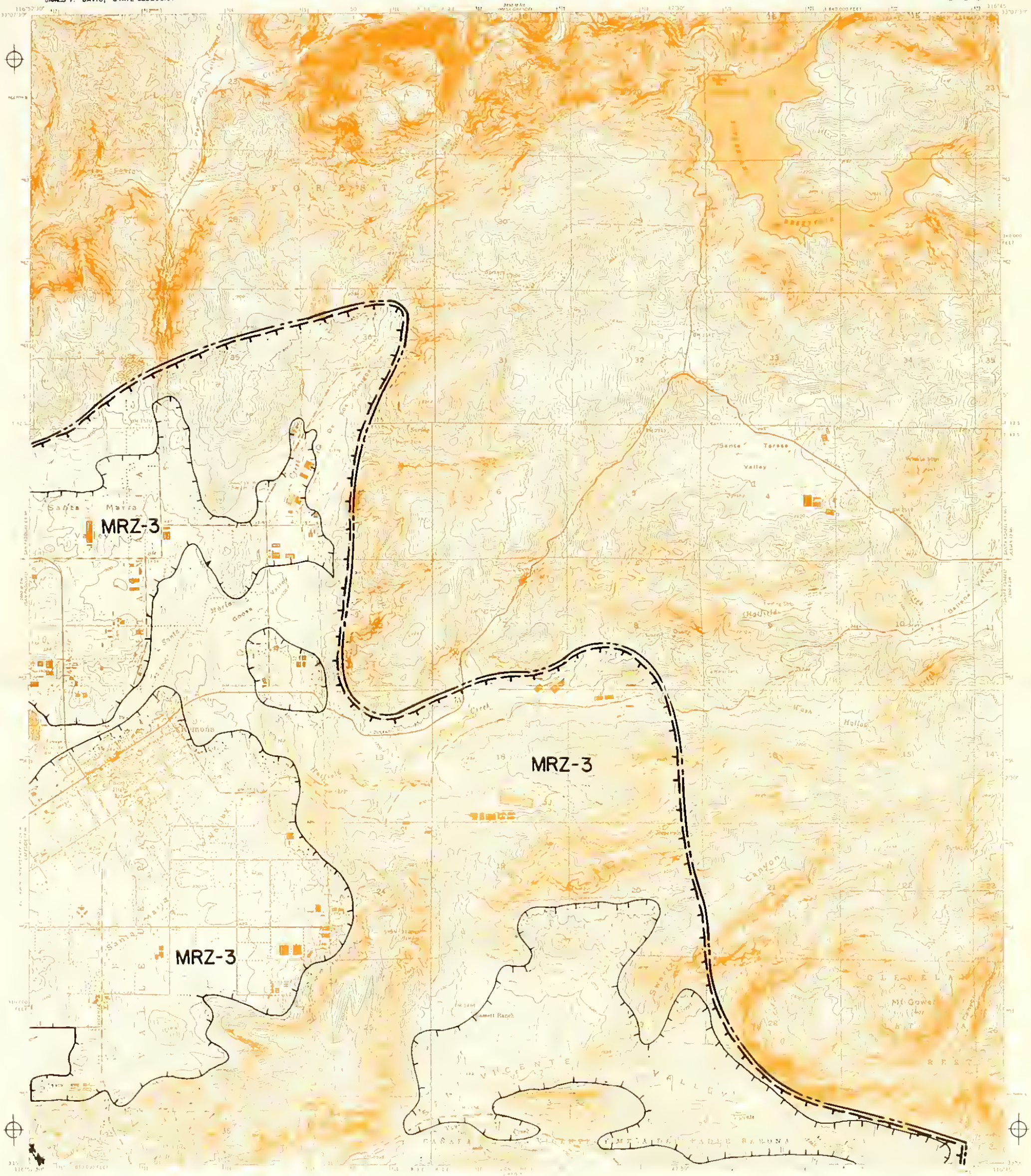
PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST FEBRUARY 15, 1983

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

RAMONA QUADRANGLE
SPECIAL REPORT 153
PLATE 15



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

EXPLANATION

Drill hole

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PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

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See text for additional explanation of MRZ Symbols.

RAMONA, CALIF.

MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST FEBRUARY 15, 1983

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

DEL MAR QUADRANGLE
SPECIAL REPORT 153
PLATE 16

TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

EXPLANATION

Drill hole

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PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

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See text for additional explanation of MRZ Symbols.

CONTOUR INTERVAL 20 FEET

DEL MAR, CALIF.

MINERAL LAND CLASSIFICATION MAP

AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

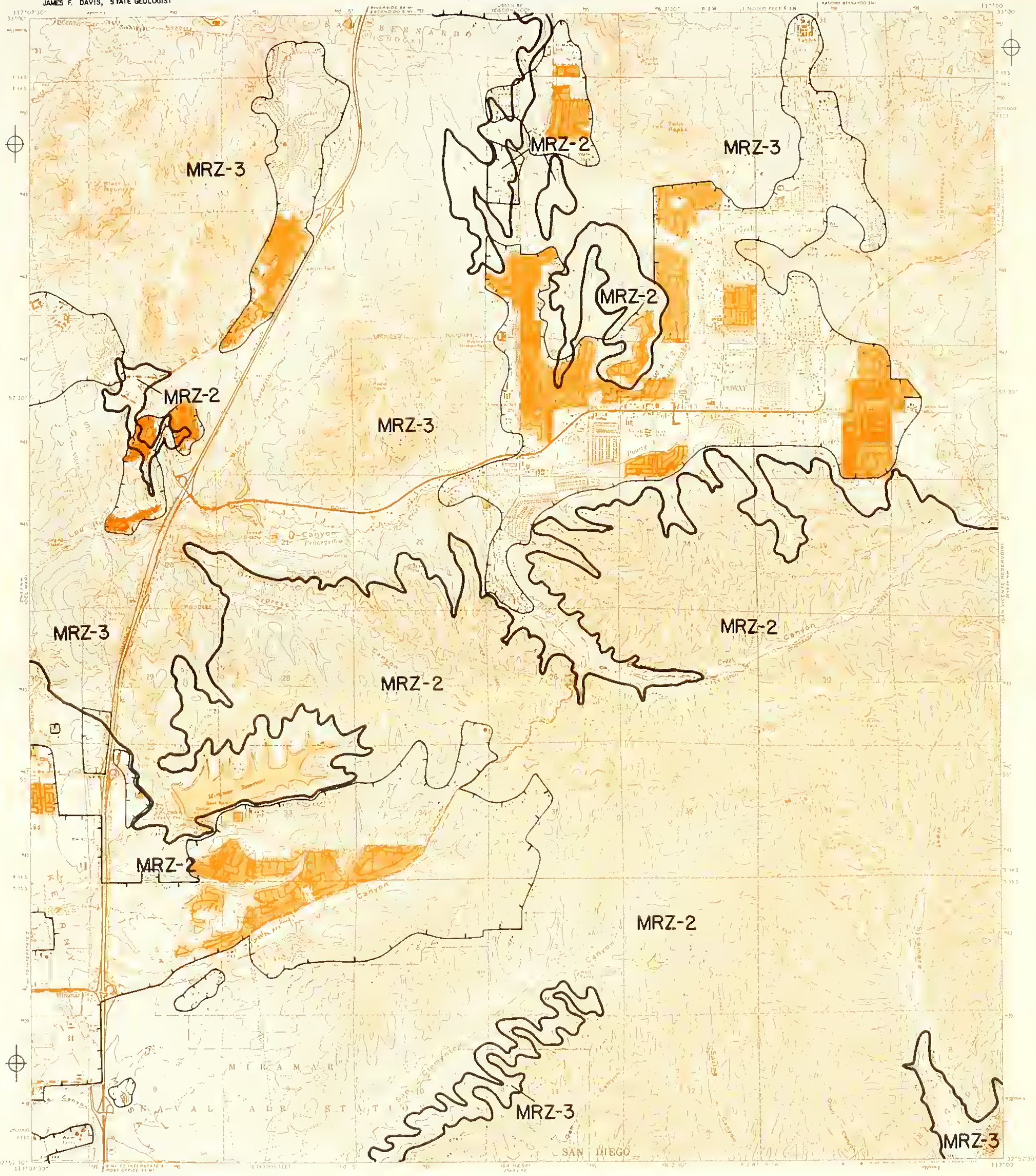
James F. Davis
STATE GEOLOGIST FEBRUARY 15, 1983

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

POWAY QUADRANGLE

PLATE 17



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

POWAY, CALIF

EXPLANATION

Drill hole

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PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

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MINERAL LAND CLASSIFICATION MAP

AGGREGATE RESOURCES ONLY

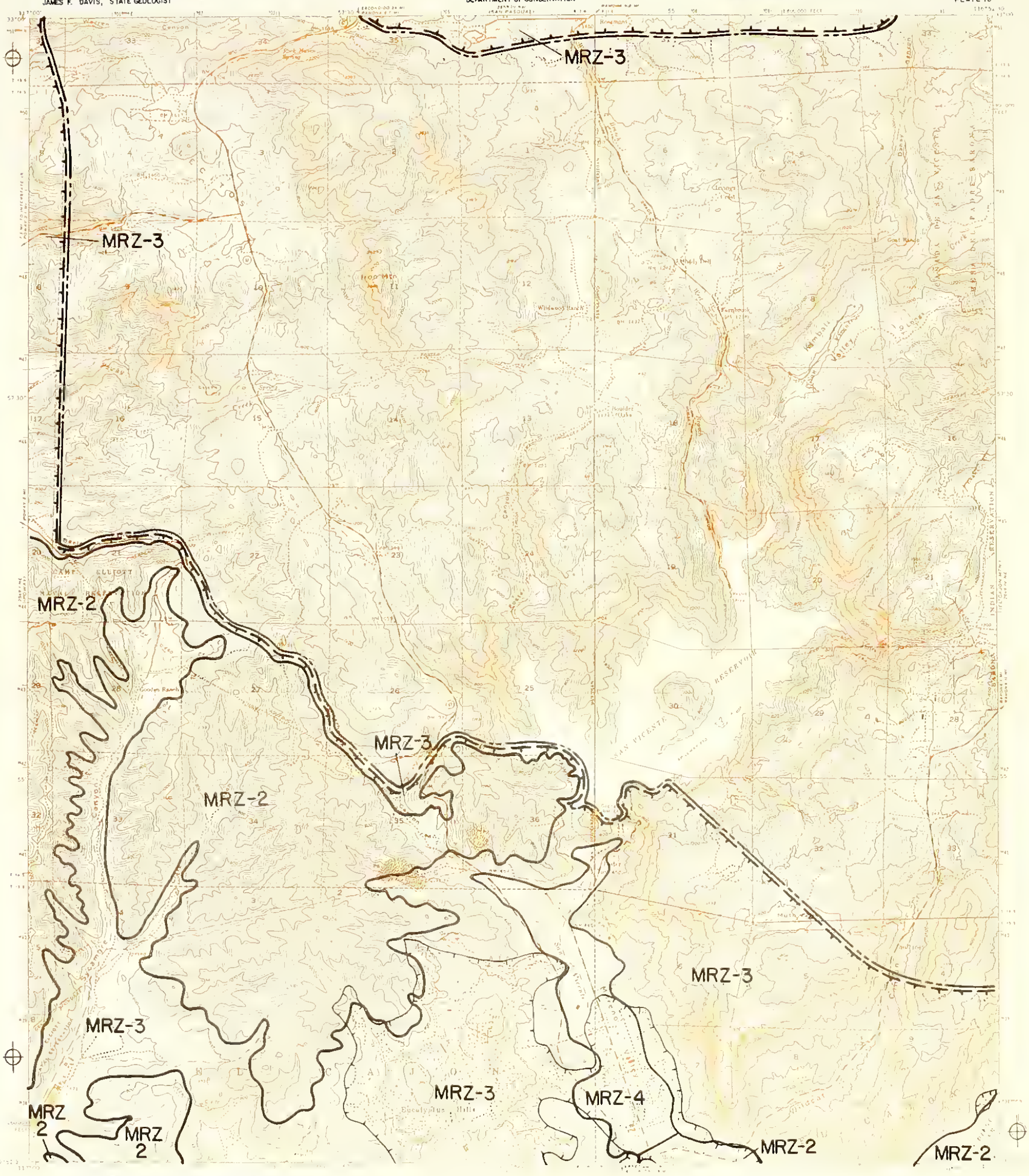
PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST FEBRUARY 15, 1983

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

SAN VICENTE RESERVOIR QUADRANGLE
SPECIAL REPORT 153
PLATE 18



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

EXPLANATION

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PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

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MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST FEBRUARY 15, 1983

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

EL CAJON MTN QUADRANGLE
SPECIAL REPORT 153
PLATE 19

TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

CONTOUR INTERVAL 40 FEET
DATUM IS MEAN SEA LEVEL

EXPLANATION

- Drill hole

OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
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EL CAJON MTN., CALIF.

MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

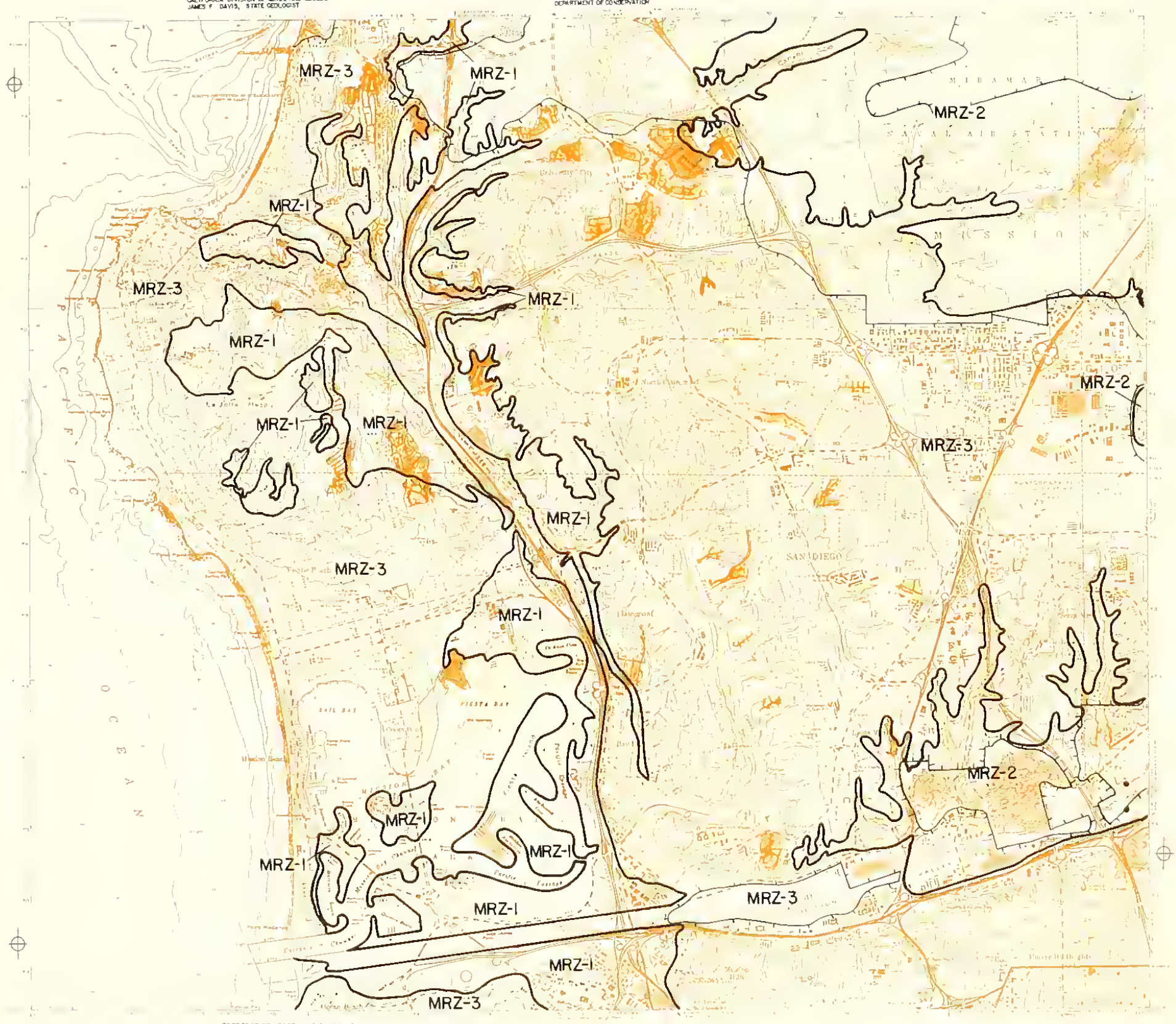
PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST FEBRUARY 15, 1983

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

LA JOLLA QUADRANGLE
SPECIAL REPORT 153
PLATE 20



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

EXPLANATION

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MINERAL LAND CLASSIFICATION MAP

AGGREGATE RESOURCES ONLY

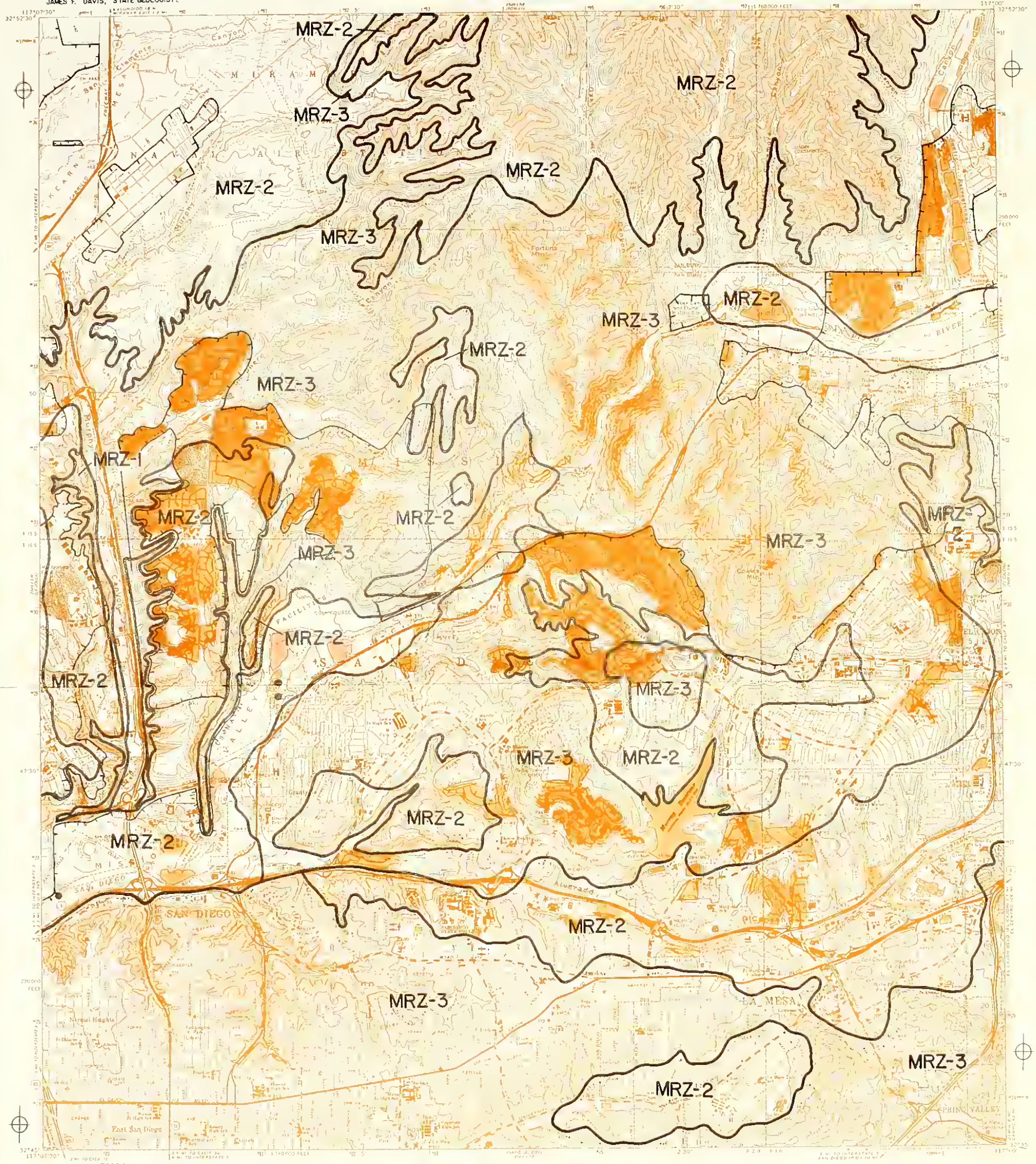
PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST FEBRUARY 15, 1983

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

LA MESA QUADRANGLE
SPECIAL REPORT 153
PLATE 21



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10 FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

LA MESA, CALIF

EXPLANATION

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MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

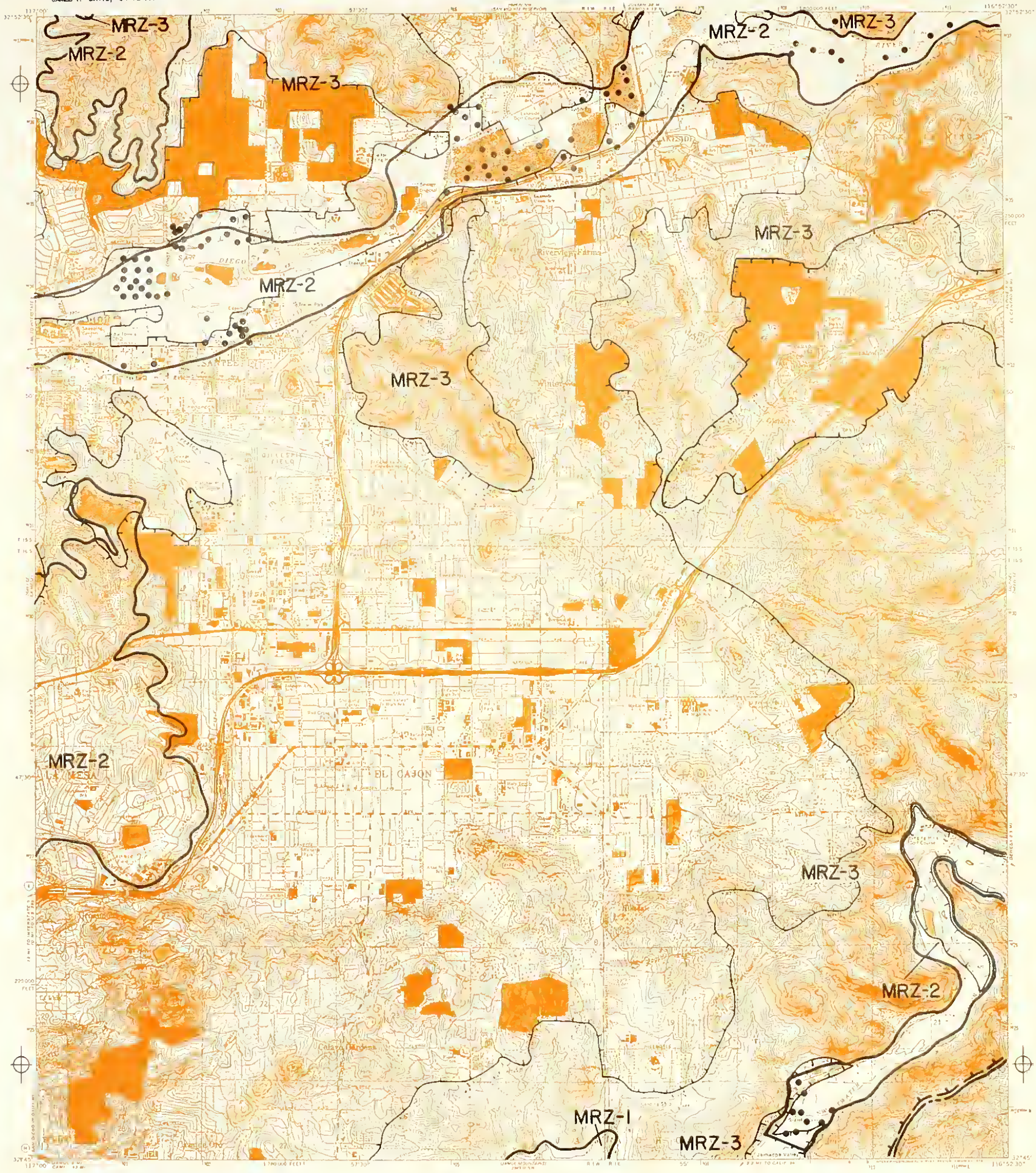
PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST FEBRUARY 15, 1983

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

EL CAJON QUADRANGLE
SPECIAL REPORT 153
PLATE 22



TOPOGRAPHIC BASE MAP BY U.S GEOLOGICAL SURVEY
Reduced from 1:24,000

CONTOUR INTERVAL 20 FEET
DASHED LINES REPRESENT 10 FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

EL CAJON, CALIF.

EXPLANATION

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PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

MRZ-2

- MRZ-1 Areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence.
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- MRZ-3 Areas containing mineral deposits the significance of which cannot be evaluated from available data.
- MRZ-4 Areas where available information is inadequate for assignment to any other MRZ zone.

See text for additional explanation of MRZ Symbols.

MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

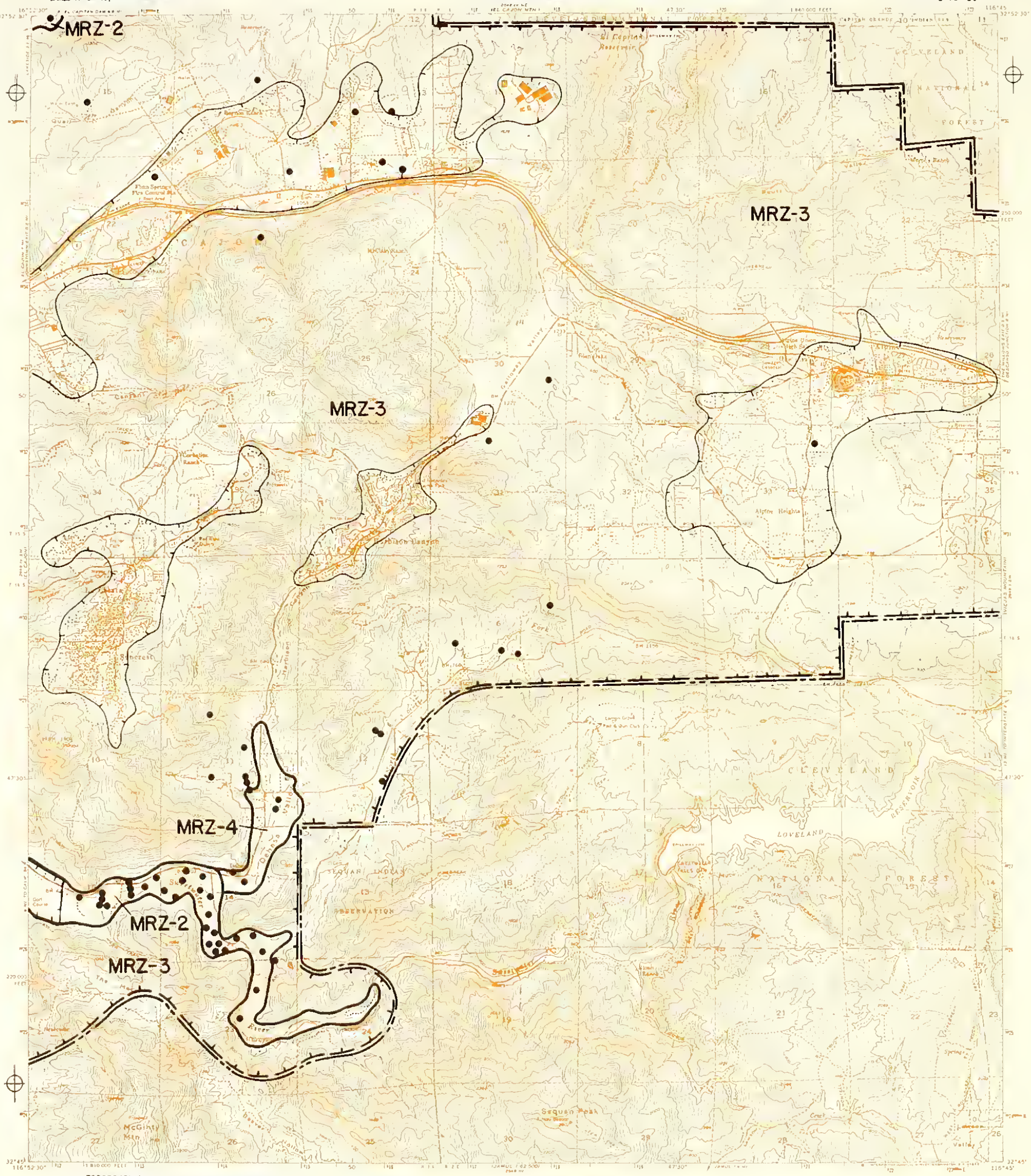
PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

STATE GEOLOGIST FEBRUARY 15, 1983

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

ALPINE QUADRANGLE
SPECIAL REPORT 153
PLATE 23



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

CONTOUR INTERVAL 40 FEET
DATUM IS MEAN SEA LEVEL

ALPINE, CALIF.

EXPLANATION

Drill hole

OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
Boundaries established from data supplied by the Office of Planning and Research with modifications developed from information supplied by local government and other sources. Hachures lie within area undergoing urbanization.

EXISTING URBAN BOUNDARIES
Boundaries established by the Office of Planning and Research and by data supplied by local government agencies and other sources to reflect present conditions. Hachures lie within urban area.

PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

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MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

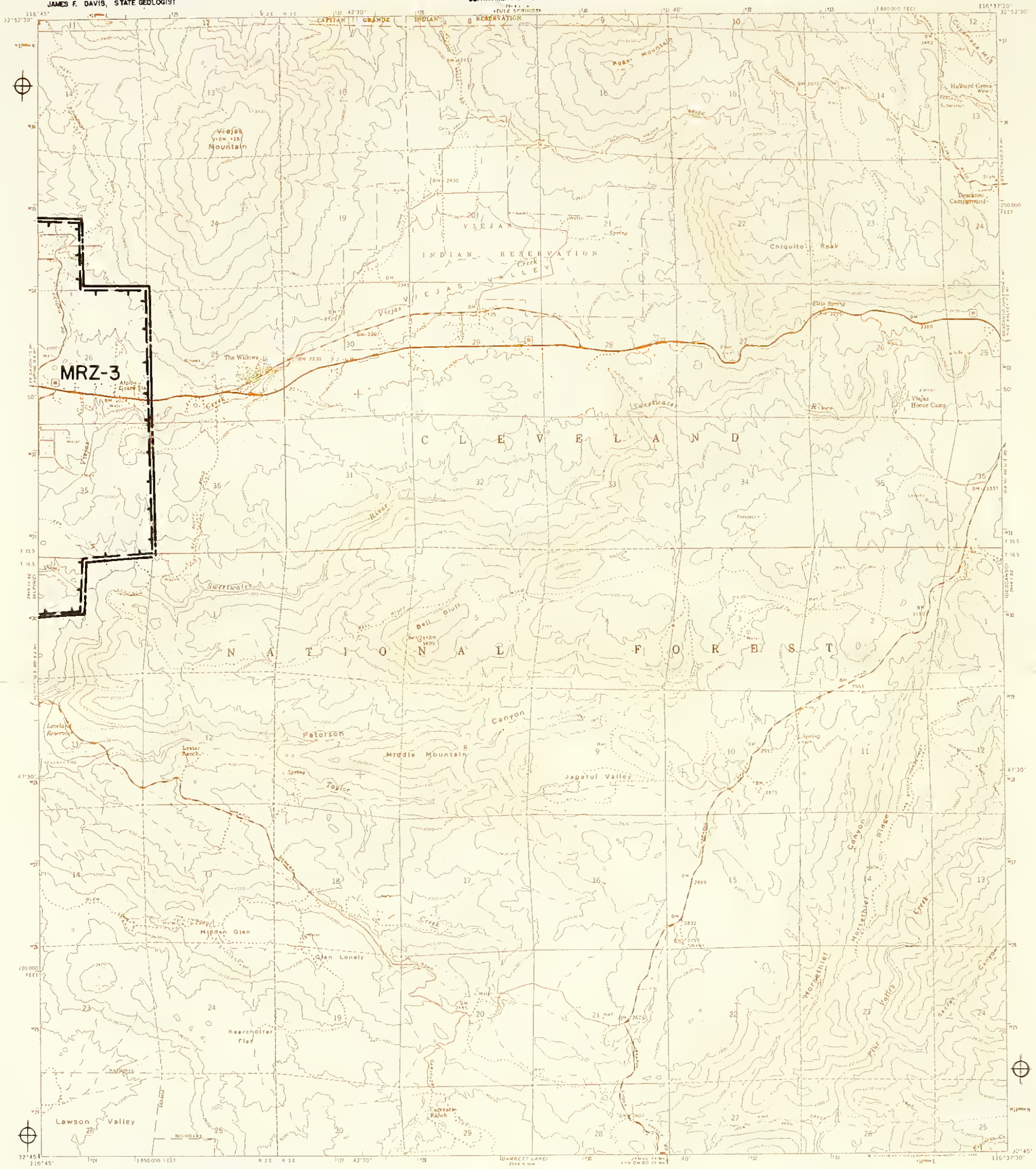
PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST FEBRUARY 15, 1983

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

VIEJAS MOUNTAIN QUADRANGLE
SPECIAL REPORT 153
PLATE 24



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

CONTOUR INTERVAL 40 FEET
DATUM IS MEAN SEA LEVEL

VIEJAS MOUNTAIN, CALIF.

EXPLANATION

- Drill hole

OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
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PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

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MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST FEBRUARY 15, 1983

SPECIAL PRINTING
Contours and woodland symbols omitted

CALIFORNIA DIVISION OF MINES AND GEOLOGY
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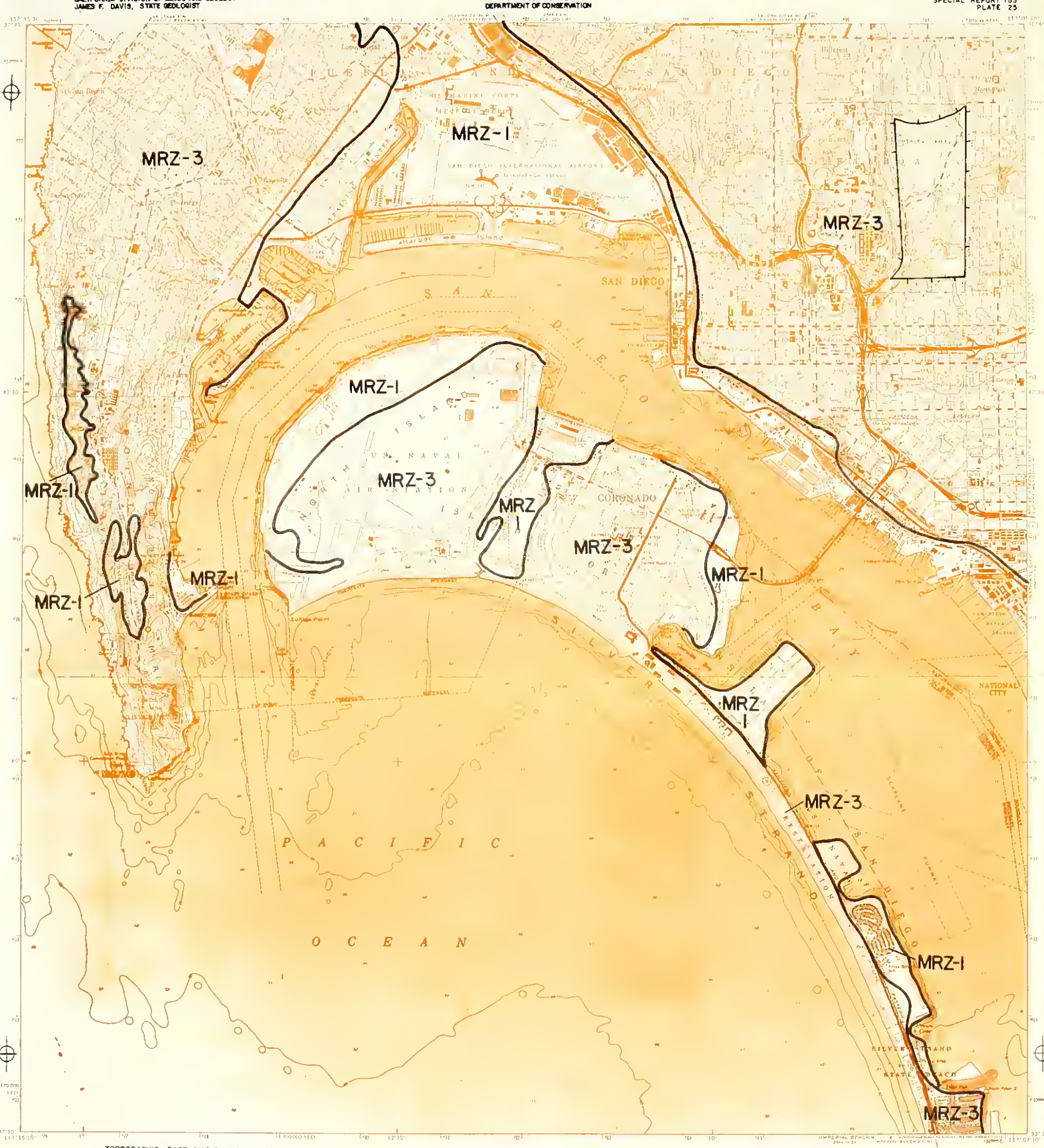
STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

POINT LOMA QUADRANGLE
SPECIAL REPORT 153
PLATE 25



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

EXPLANATION

Drill hole

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(see text for discussion)

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See text for additional explanation of MRZ Symbols.

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929
DEPTH CURVES AND SOUNDINGS IN FEET—DATUM IS MEAN LOWER LOW WATER

POINT LOMA, CALIF

MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

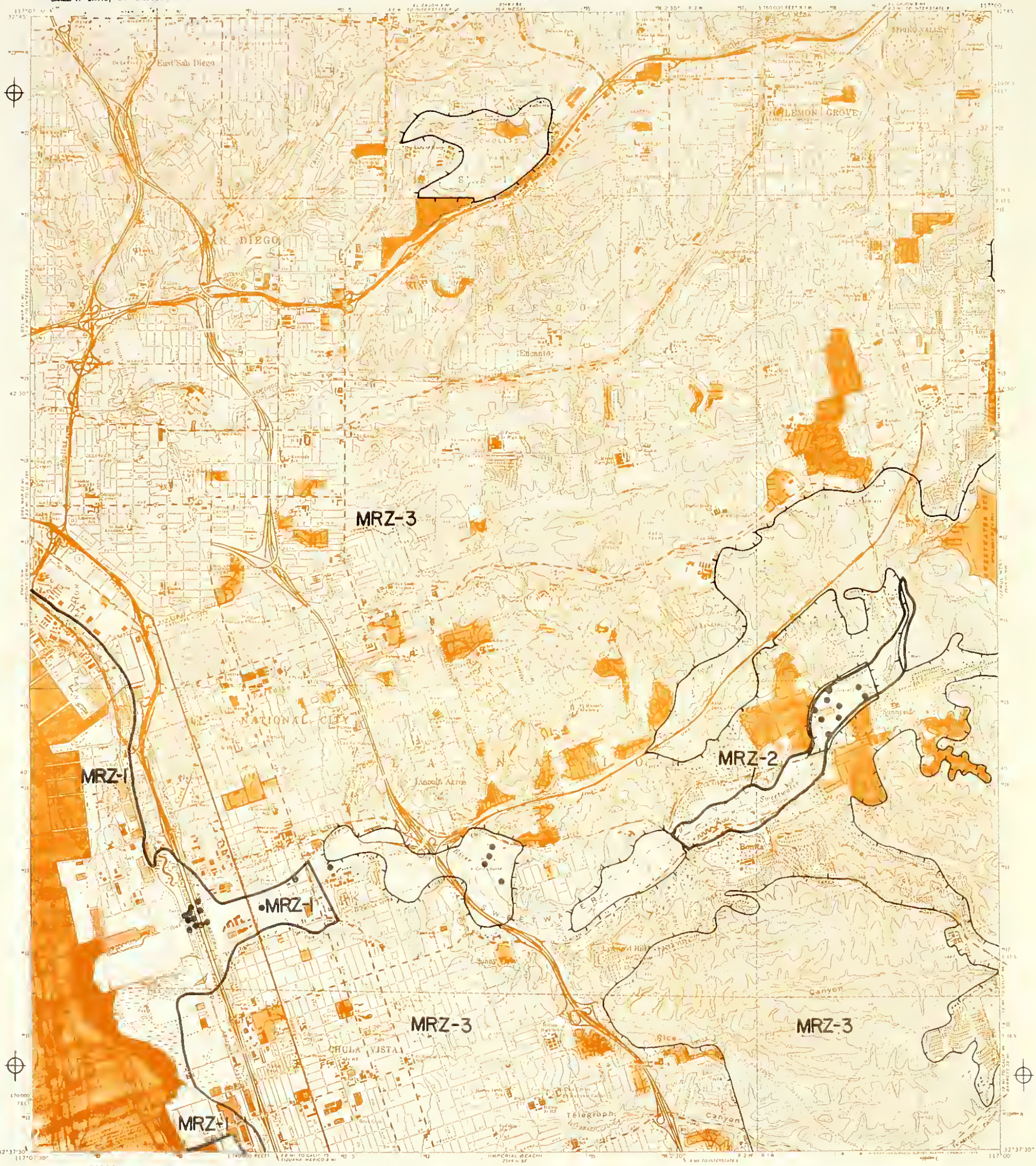
PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST FEBRUARY 15, 1983

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

NATIONAL CITY QUADRANGLE
SPECIAL REPORT 153
PLATE 26



TOPOGRAPHIC BASE MAP BY U.S GEOLOGICAL SURVEY
Reduced from 1:24,000

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929
DEPTH CURVES AND SOUNDINGS IN FEET—DATUM IS MEAN LOWER LOW WATER

NATIONAL CITY, CALIF

EXPLANATION

Drill hole

OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
Boundaries established from data supplied by the Office of Planning and Research with modifications developed from information supplied by local government and other sources. Hachures lie within area undergoing urbanization.

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PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

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See text for additional explanation of MRZ Symbols.

MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST FEBRUARY 15, 1983

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

JAMUL MOUNTAINS QUADRANGLE
SPECIAL REPORT 153
PLATE 27

MRZ-3
MRZ-1
MRZ-3
MRZ-4
MRZ-3
MRZ-2
MRZ-3

TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

EXPLANATION

- Drill hole

OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
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PRODUCTION-CONSUMPTION REGION BOUNDARY
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See text for additional explanation of MRZ Symbols.

CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

JAMUL MOUNTAINS, CALIF.

MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST FEBRUARY 15, 1983

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

DULZURA QUADRANGLE
SPECIAL REPORT 153
PLATE 2B

MRZ-3
North Jamul
Jamul
Jamul Mountains
Otay Mountains
Otay Valley
Otay Reservoir
Otay Lake
Proctor Valley
Dulzura
Campo
Barrett Junction
Barrett Lake
Morena Reservoir
Cottonwood Creek
Dulzura Creek
Campo Creek
Potrero Creek
Tecate Creek
Cameron Creek
Pine Valley
Pine Valley Creek
Corral Canyon
Live Oak Canyon
Boulder Creek
Buckman Springs
Lyons Valley
Lyons Peak
Hauser Canyon
Hauser Mountain
McGinty Mountain
Wood Canyon
Wood Valley
Potrero
Tecate
Tecate Peak
Table Mountain
Table Mountain Reservoir
Japatul Valley
Japatul Creek
Japatul Valley Road
Dulzura Conn. Ditch
Dulzura Conn. Ditch No. 2
Dulzura Conn. Ditch No. 3
Dulzura Conn. Ditch No. 4
Dulzura Conn. Ditch No. 5
Dulzura Conn. Ditch No. 6
Dulzura Conn. Ditch No. 7
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Dulzura Conn. Ditch No. 97
Dulzura Conn. Ditch No. 98
Dulzura Conn. Ditch No. 99
Dulzura Conn. Ditch No. 100

TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

CONTOUR INTERVAL 40 FEET
DATUM IS MEAN SEA LEVEL

DULZURA, CALIF.

EXPLANATION

- Drill hole

OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
Boundaries established from data supplied by the Office of Planning and Research with modifications developed from information supplied by local government and other sources. Hachures lie within area undergoing urbanization.

EXISTING URBAN BOUNDARIES
Boundaries established by the Office of Planning and Research and by data supplied by local government agencies and other sources to reflect present conditions. Hachures lie within urban area.

PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

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See text for additional explanation of MRZ Symbols.

MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST FEBRUARY 15, 1983

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

IMPERIAL BEACH QUADRANGLE
SPECIAL REPORT 153
PLATE 29

TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 124,000

EXPLANATION

Drill hole

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(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

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See text for additional explanation of MRZ Symbols.

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT HALFWAY CONTOURS
DATUM IS MEAN SEA LEVEL
SPECIAL PRINTING

IMPERIAL BEACH, CALIF

MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

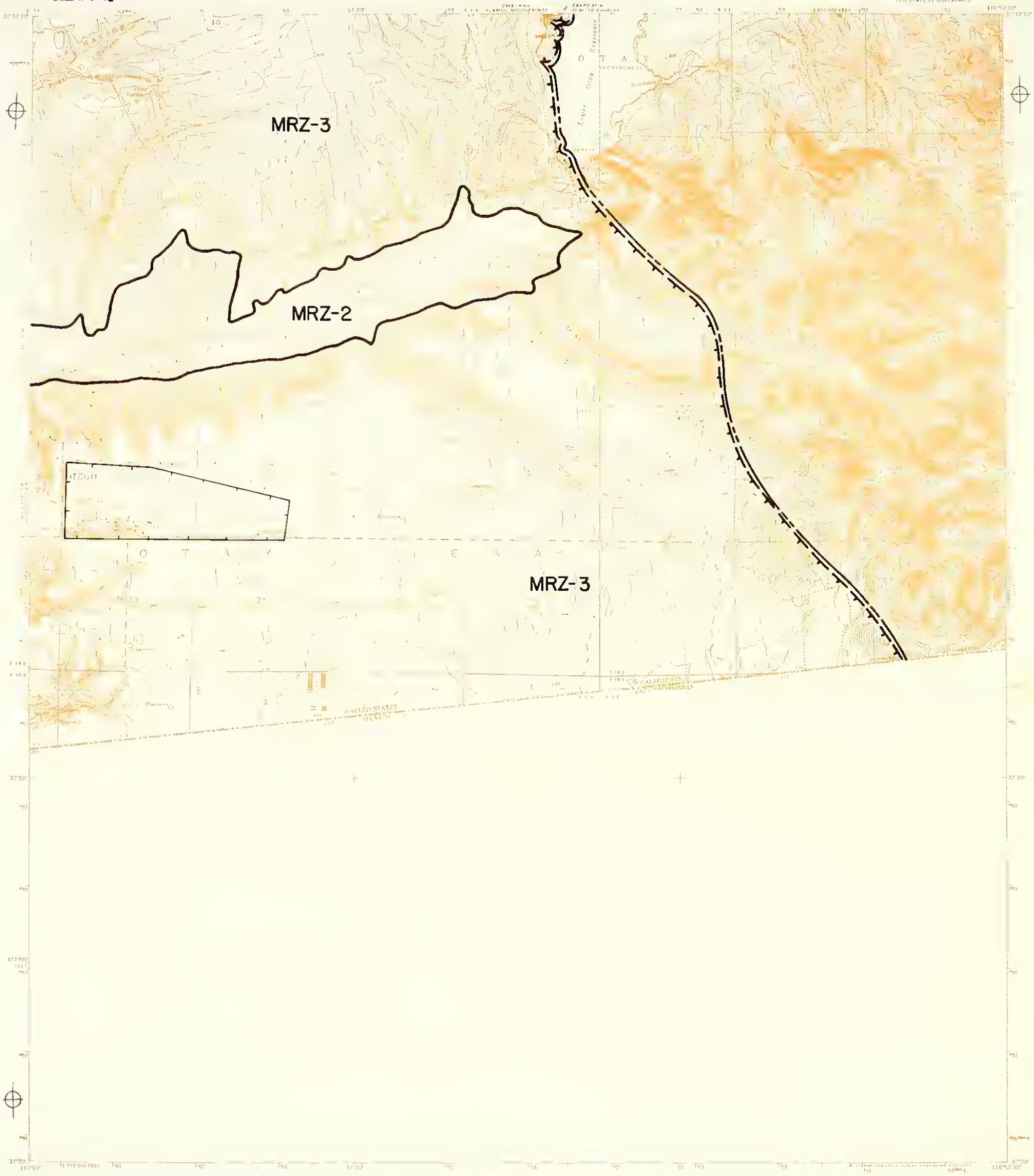
PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

STATE GEOLOGIST FEBRUARY 15, 1983

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

OTAY MESA QUADRANGLE
SPECIAL REPORT 153
PLATE 30



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

EXPLANATION

Drill hole

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CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

OTAY MESA, CALIF

MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

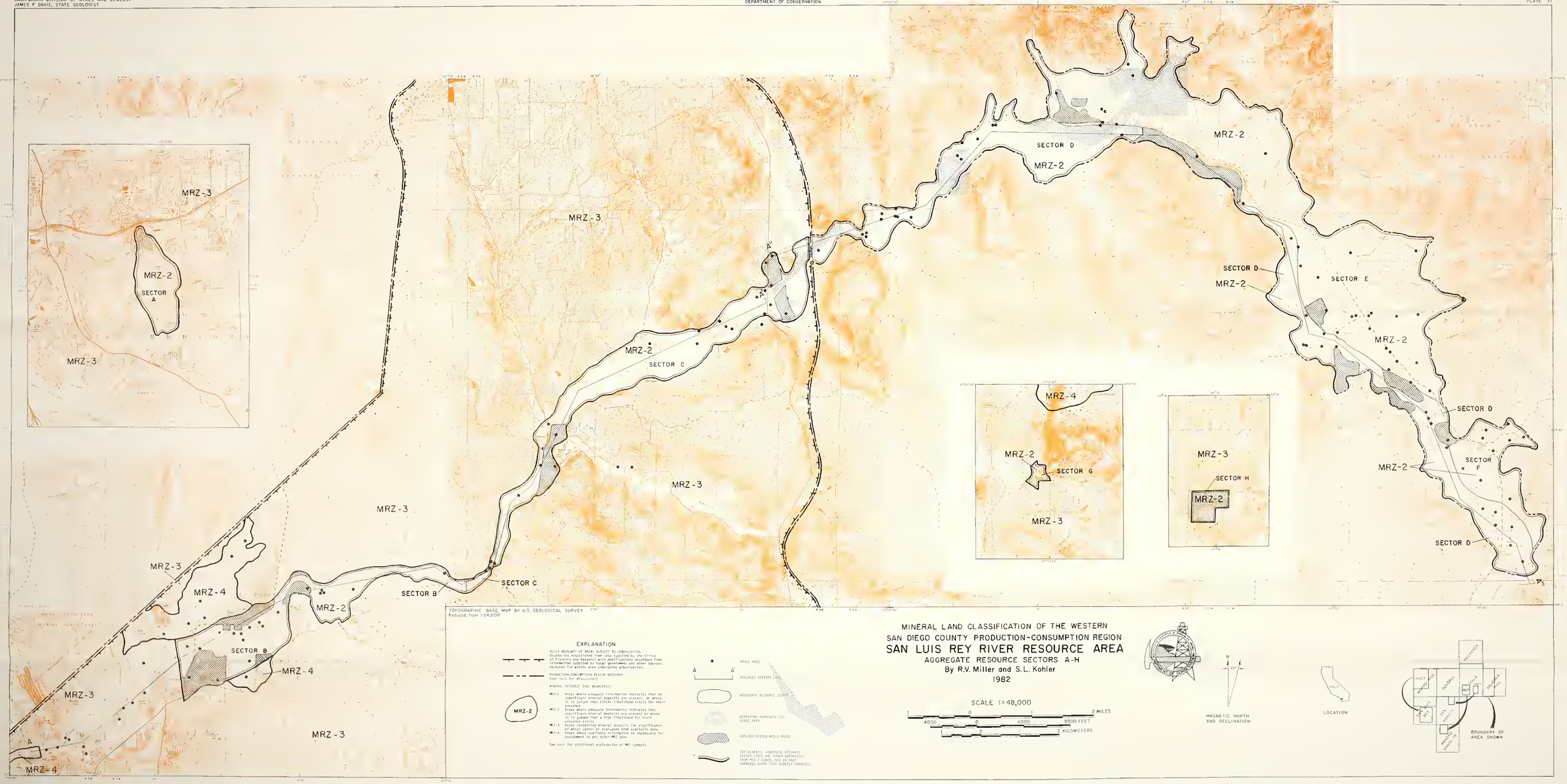
PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST FEBRUARY 15, 1983

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

SPECIAL REPORT 153
PLATE 5J



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

EXPLANATION

OUTER BOUNDARY OF AREAL EXTENT TO URBANIZATION. Boundaries established from data supplied by the Office of Planning and Research with modifications developed from information submitted by local governments and other sources. Hatchures tic within area undergoing urbanization.

PRODUCTION-CONSUMPTION REGION BOUNDARY (See text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

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See text for additional explanation of MRZ symbols

MRZ-2

DRILL HOLE

GEOLOGIC SECTION LINE

AGGREGATE RESOURCE SECTOR

OPERATING AGGREGATE PIT LEASE AREA

NON-SECTORED MRZ-2 AREAS

TOP CLIMBS, AQUEDUCT RESOURCE SECTOR LINES ARE SHOWN SEPARATELY FROM MRZ-2 LINES, BUT IN FACT COINCIDE WHERE THEY CLOSELY PARALLEL.

MINERAL LAND CLASSIFICATION OF THE WESTERN SAN DIEGO COUNTY PRODUCTION-CONSUMPTION REGION

SAN LUIS REY RIVER RESOURCE AREA

AGGREGATE RESOURCE SECTORS A-H

By R.V. Miller and S.L. Kohler

1982

SCALE 1:48,000

2 MILES
8000 FEET
2 KILOMETERS

MAGNETIC NORTH AND DECLINATION

LOCATION

BOUNDARY OF AREA SHOWN

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

SPECIAL REPORT 153
PLATE 32

EXPLANATION

OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
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PRODUCTION-CONSUMPTION REGION BOUNDARY
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MRZ-2

See text for additional explanation of MRZ symbols.

DRILL HOLE

B B'

GEOLOGIC SECTION LINE

AGGREGATE RESOURCE SECTOR *

NON-SECTORIZED MRZ-2 AREAS

FOR CLARITY, AGGREGATE RESOURCE SECTOR LINES ARE SHOWN SEPARATELY FROM MRZ-2 LINES, BUT IN FACT COINCIDE WHERE THEY CLOSELY PARALLEL.

NOTE: DUE TO FREQUENT CHANGES IN PERMITTED AGGREGATE EXTRACTION AREAS IN THE SAN PASQUAL VALLEY, SUCH AREAS ARE NOT SHOWN.

MRZ-2
MRZ-3
MRZ-4
SECTOR I
MRZ-2
MRZ-3
MRZ-2
B'
SECTOR I
B
MRZ-2

R2W R1W 57'30" R1W R1E 55' 33°07'30"
T.12S. T.13S.
117°00' 57'30" R1W R1E 55'

MINERAL LAND CLASSIFICATION OF THE WESTERN SAN DIEGO COUNTY PRODUCTION-CONSUMPTION REGION

SAN PASQUAL VALLEY RESOURCE AREA

AGGREGATE RESOURCE SECTOR I

By R.V. Miller and S.L. Kohler

1982

N
15°
MAGNETIC NORTH AND DECLINATION

CALIF
LOCATION

SCALE: 1=48,000

1 0 1 2 MILES
4000 0 4000 8000 FEET
0 2 KILOMETERS

ESCONDIDO SAN PASQUAL
BOUNDARY OF AREA SHOWN

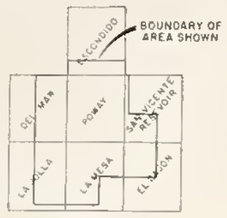
TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

LIBRARY OF THE UNIVERSITY OF CALIFORNIA, DAVIS

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

SPECIAL REPORT 153
PLATE 33



EXPLANATION

OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
Boundaries established from data supplied by the Office of Planning and Research with modifications developed from information supplied by local government and other sources. Hacherures lie within area undergoing urbanization.

PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

MRZ-1 Areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence.

MRZ-2 Areas where adequate information indicates that significant mineral deposits are present or where it is judged that a high likelihood for their presence exists.

MRZ-3 Areas containing mineral deposits the significance of which cannot be evaluated from available data

MRZ-4 Areas where available information is inadequate for assignment to any other MRZ zone.

See text for additional explanation of MRZ symbols

DRILL HOLE

GEOLOGIC SECTION LINE

AGGREGATE RESOURCE SECTION *

OPERATING AGGREGATE PIT LEASE AREA

NON-SECTORIZED MRZ-2 AREAS

* FOR CLARITY, AGGREGATE RESOURCE SECTOR LINES ARE SHOWN SEPARATELY FROM MRZ-2 LINES, BUT IN FACT COINCIDE WHERE THEY CLOSELY PARALLEL.

NOTE: SECTORS 2 & L HAVE BEEN SUBDIVIDED FOR [illegible] DESIGNATION PROCESS. NO TEXT REFERENCE IS MADE OF THESE SUBDIVISIONS.

FOR SECTOR DESIGNATION SEE PLATE 34 (Upper San Diego River)

MINERAL LAND CLASSIFICATION OF THE WESTERN SAN DIEGO COUNTY PRODUCTION-CONSUMPTION REGION

KEARNY MESA - MISSION VALLEY RESOURCE AREA

AGGREGATE RESOURCE SECTORS J-L

By R.V Miller and S.L. Kohler

1982

SCALE: 1:48,000

2 MILES 0 2
4000 0 4000 8000 FEET
2 KILOMETERS 0 2

MAGNETIC NORTH AND DECLINATION

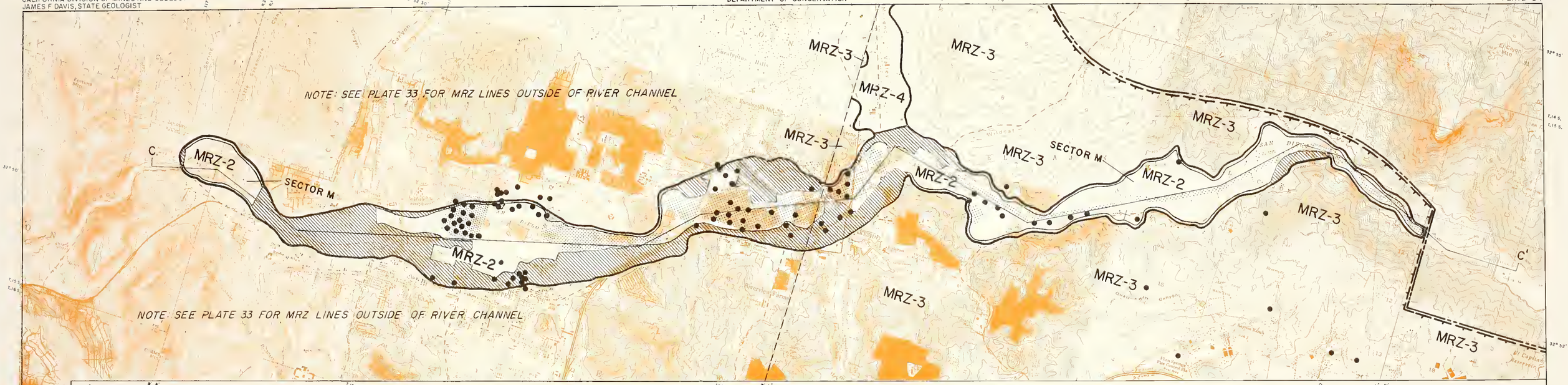
LOCATION

TOPOGRAPHIC BASE BY U S GEOLOGICAL SURVEY
Reduced from 1:24,000

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

SPECIAL REPORT 153
PLATE 34



EXPLANATION

OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
Boundaries established from data supplied by the Office of Planning and Research with modifications developed from information supplied by local government and other sources. Hachures lie within area undergoing urbanization.

PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

MRZ-2

MRZ-1 Areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence.

MRZ-2 Areas where adequate information indicates that significant mineral deposits are present or where it is judged that a high likelihood for their presence exists.

MRZ-3 Areas containing mineral deposits the significance of which cannot be evaluated from available data.

MRZ-4 Areas where available information is inadequate for assignment to any other MRZ zone.

See text for additional explanation of MRZ symbols.

DRILL HOLE

C C' GEOLOGIC SECTION LINE

AGGREGATE RESOURCE SECTOR *

OPERATING AGGREGATE PIT LEASE AREA

NON-SECTORIZED MRZ-2 AREAS

* FOR CLARITY, AGGREGATE RESOURCE SECTOR LINES ARE SHOWN SEPARATELY FROM MRZ-2 LINES, BUT IN FACT COINCIDE WHERE THEY CLOSELY PARALLEL

MINERAL LAND CLASSIFICATION OF THE WESTERN SAN DIEGO COUNTY PRODUCTION-CONSUMPTION REGION

UPPER SAN DIEGO RIVER RESOURCE AREA

AGGREGATE RESOURCE SECTOR M

By R.V. Miller and S.L. Kohler

1982

SCALE: 1=48,000

0 2 MILES
4000 0 4000 8000 FEET
0 2 KILOMETERS

MAGNETIC NORTH AND DECLINATION

LOCATION

BOUNDARY OF AREA SHOWN

TOPOGRAPHIC BASE BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

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DEPARTMENT OF CONSERVATION

SPECIAL REPORT 153
PLATE 35

TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

EXPLANATION

OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
Boundaries established from data supplied by the Office of Planning and Research with modifications developed from information supplied by local government and other sources. Hachures lie within area undergoing urbanization.

PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

MRZ-2

MRZ-1 Areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence.

MRZ-2 Areas where adequate information indicates that significant mineral deposits are present or where it is judged that a high likelihood for their presence exists.

MRZ-3 Areas containing mineral deposits the significance of which cannot be evaluated from available data.

MRZ-4 Areas where available information is inadequate for assignment to any other MRZ zone.

See text for additional explanation of MRZ symbols.

DRILL HOLE

D D' GEOLOGIC SECTION LINE

AGGREGATE RESOURCE SECTOR *

OPERATING AGGREGATE PIT LEASE AREA

NON-SECTORIZED MRZ-2 AREAS

* FOR CLARITY, AGGREGATE RESOURCE SECTOR LINES ARE SHOWN SEPARATELY FROM MRZ-2 LINES, BUT IN FACT COINCIDE WHERE THEY CLOSELY PARALLEL.

MINERAL LAND CLASSIFICATION OF THE WESTERN SAN DIEGO COUNTY PRODUCTION-CONSUMPTION REGION

SWEETWATER RIVER RESOURCE AREA

AGGREGATE RESOURCE SECTORS N-Q

By R.V. Miller and S.L. Kohler

1982

SCALE: 1=48,000

0 2 MILES
4000 0 4000 8000 FEET
0 2 KILOMETERS

MAGNETIC NORTH AND DECLINATION

LOCATION

BOUNDARY OF AREA SHOWN

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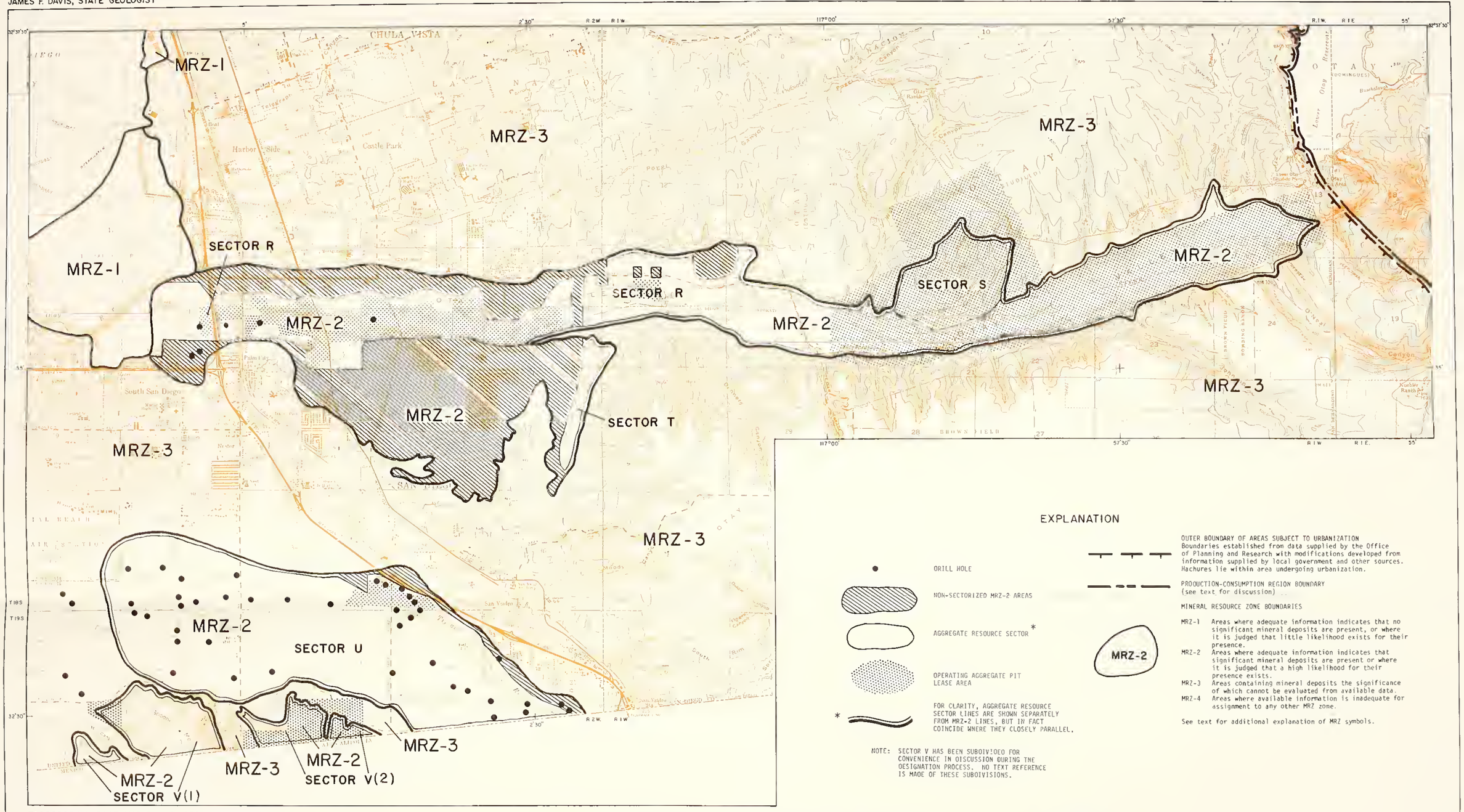
DEPARTMENT OF CONSERVATION

SPECIAL REPORT 153
PLATE 36



EXPLANATION

- DRILL HOLE
- NON-SECTORIZED MRZ-2 AREAS
- AGGREGATE RESOURCE SECTOR *
- OPERATING AGGREGATE PIT LEASE AREA
- * FOR CLARITY, AGGREGATE RESOURCE SECTOR LINES ARE SHOWN SEPARATELY FROM MRZ-2 LINES, BUT IN FACT COINCIDE WHERE THEY CLOSELY PARALLEL.

NOTE: SECTOR V HAS BEEN SUBDIVIDED FOR CONVENIENCE IN DISCUSSION DURING THE DESIGNATION PROCESS. NO TEXT REFERENCE IS MADE OF THESE SUBDIVISIONS.

- OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
  Boundaries established from data supplied by the Office of Planning and Research with modifications developed from information supplied by local government and other sources. Hachures lie within area undergoing urbanization.
- PRODUCTION-CONSUMPTION REGION BOUNDARY (see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

MRZ-2

- MRZ-1 Areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence.
- MRZ-2 Areas where adequate information indicates that significant mineral deposits are present or where it is judged that a high likelihood for their presence exists.
- MRZ-3 Areas containing mineral deposits the significance of which cannot be evaluated from available data.
- MRZ-4 Areas where available information is inadequate for assignment to any other MRZ zone.

See text for additional explanation of MRZ symbols.

TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

MINERAL LAND CLASSIFICATION OF THE WESTERN SAN DIEGO COUNTY PRODUCTION-CONSUMPTION REGION

OTAY VALLEY, TIJUANA RIVER, AND BORDER HIGHLANDS RESOURCE AREAS

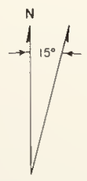
AGGREGATE RESOURCE SECTORS R-V

By R.V. Miller and S.L. Kohler

1982

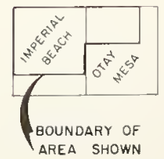
SCALE: 1=48,000

1 0 2 MILES
4000 0 4000 8000 FEET
0 2 KILOMETERS



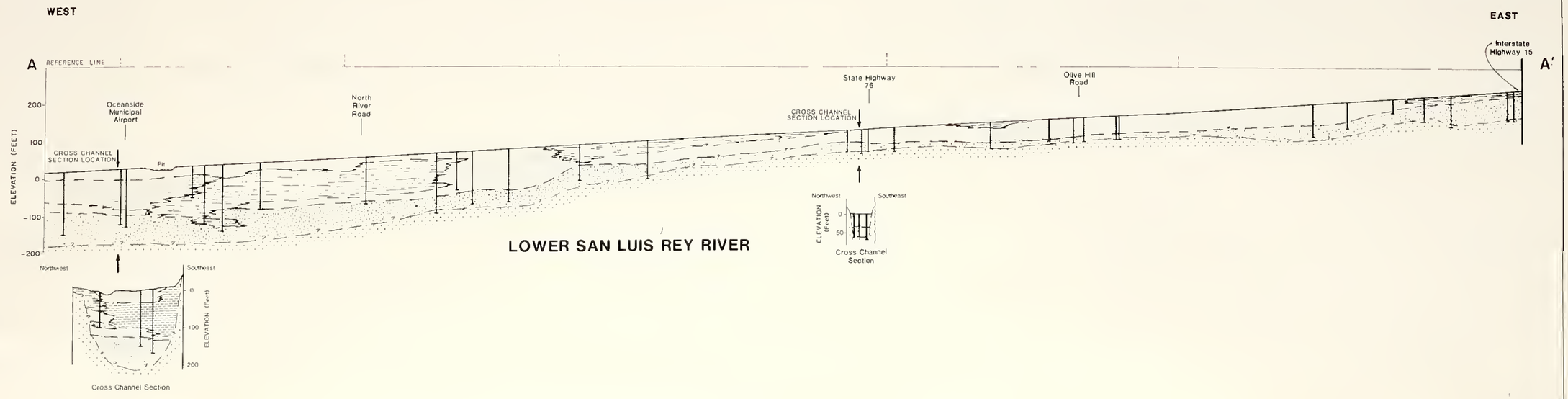
MAGNETIC NORTH AND DECLINATION

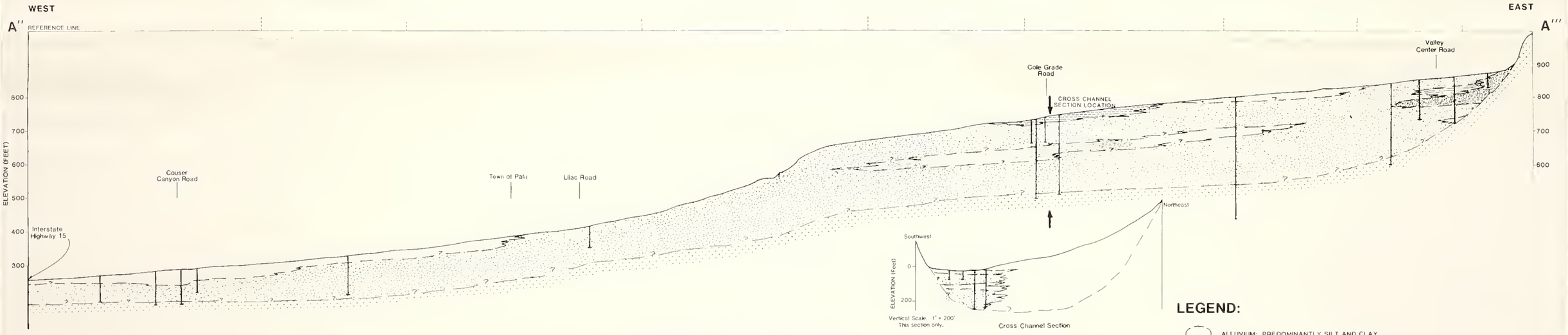
LOCATION

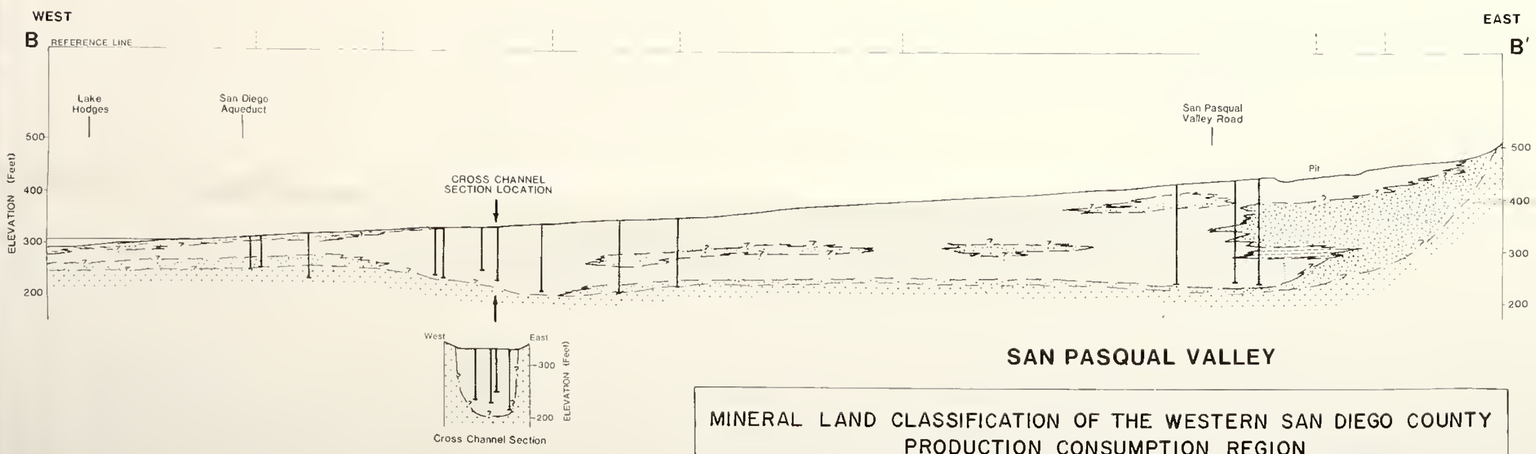


BOUNDARY OF AREA SHOWN

GIFT UNIVERSITY OF CALIFORNIA DAVIS







LEGEND:

- ALLUVIUM: PREDOMINANTLY SILT AND CLAY
- ALLUVIUM: PREDOMINANTLY SILTY FINE SAND
- ALLUVIUM: PREDOMINANTLY SAND
- ALLUVIUM: PREDOMINANTLY SAND AND GRAVEL
- ALLUVIUM: PREDOMINANTLY GRAVEL AND BOULDERS
- ANCIENT LAKE DEPOSITS (PAUMA VALLEY): PREDOMINANTLY SILT AND CLAY
- BEDROCK
- INDICATES APPROXIMATE LOCATION AND DEPTH OF WATER WELL OR TEST BORING.
- INDICATES APPROXIMATE LOCATION OF GEOLOGIC CONTACT (ACCURACY OF CONTACTS IS BASED UPON THE LEVEL OF SUBSURFACE INFORMATION
- BEND IN CROSS SECTION LINE
- REFERENCE LINE

Vertical Exaggeration 20:1

200
100
0
0 2000 4000
SCALE (Feet)

MINERAL LAND CLASSIFICATION OF THE WESTERN SAN DIEGO COUNTY PRODUCTION CONSUMPTION REGION

SAN LUIS REY RIVER AND SAN PASQUAL VALLEY GENERALIZED GEOLOGIC CROSS SECTIONS

FROM WOODWARD-CLYDE, 1979

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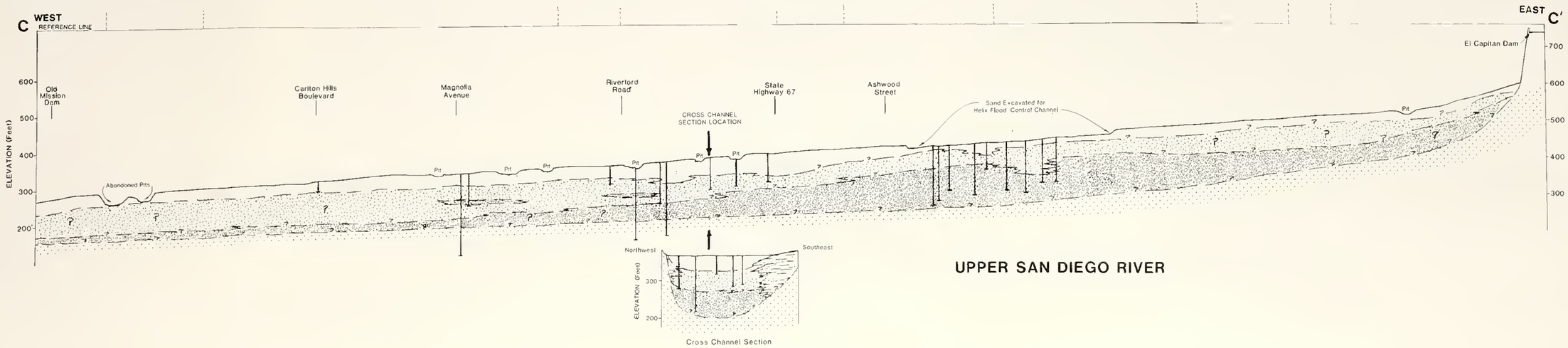
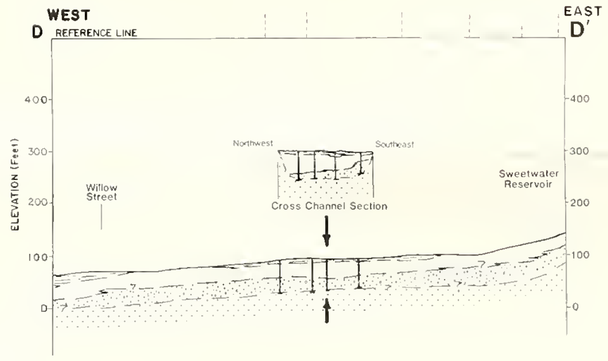
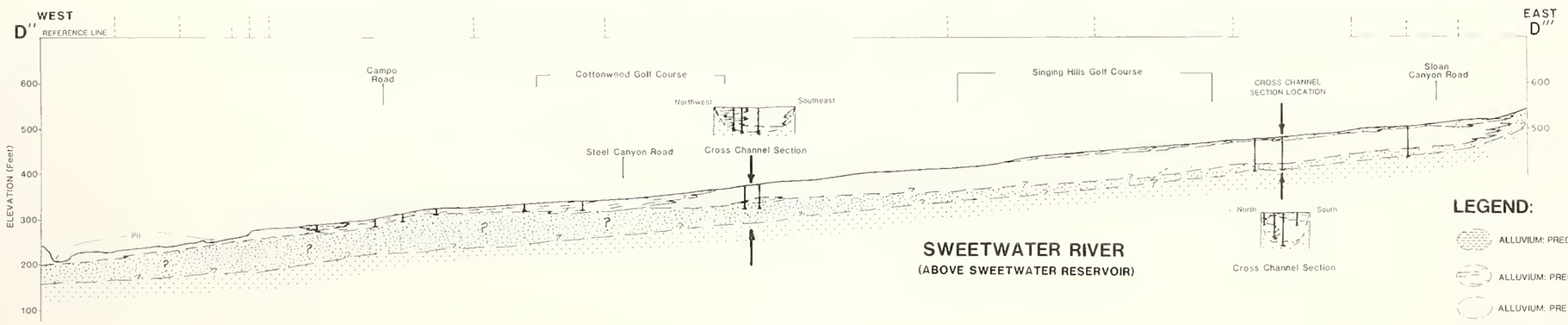
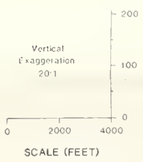
SPECIAL REPORT 153
PLATE 3B



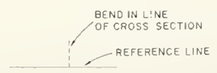






LEGEND:

- ALLUVIUM: PREDOMINANTLY SILT AND CLAY
- ALLUVIUM: PREDOMINANTLY SILTY FINE SAND
- ALLUVIUM: PREDOMINANTLY SAND
- ALLUVIUM: PREDOMINANTLY SAND AND GRAVEL
- ALLUVIUM: PREDOMINANTLY GRAVEL AND BOULDERS
- BEDROCK
- INDICATES APPROXIMATE LOCATION AND DEPTH OF WATER WELL OR TEST BORING.
- INDICATES APPROXIMATE LOCATION OF GEOLOGIC CONTACT (ACCURACY OF CONTACTS IS BASED UPON THE LEVEL OF SUBSURFACE INFORMATION - SEE TEXT FOR DISCUSSION.)



MINERAL LAND CLASSIFICATION OF THE WESTERN SAN DIEGO COUNTY PRODUCTION CONSUMPTION REGION
UPPER SAN DIEGO RIVER AND SWEETWATER RIVER GENERALIZED GEOLOGIC CROSS SECTIONS

From Woodward-Clyde 1979

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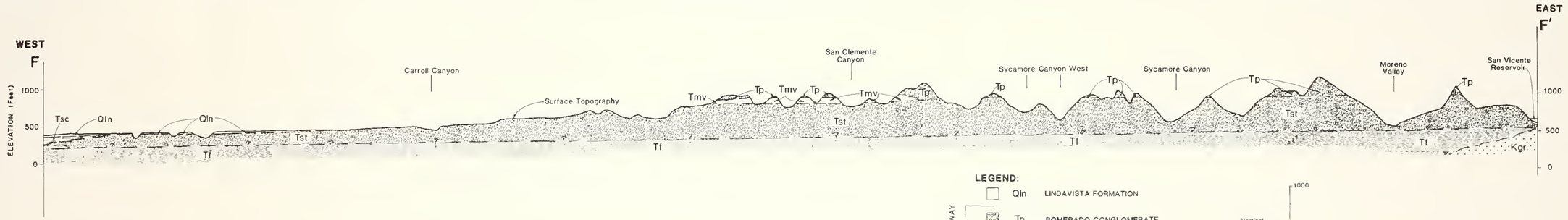

MINERAL LAND CLASSIFICATION OF THE WESTERN SAN DIEGO COUNTY PRODUCTION CONSUMPTION REGION

POWAY CONGLOMERATE GENERALIZED GEOLOGIC SECTION

FROM WOODWARD-CLYDE, 1979

LEGEND:

EOCENE POWAY GROUP

Qln	LINDAVISTA FORMATION
Tp	POMERADO CONGLOMERATE
Tmv	MISSION VALLEY FORMATION
Tst	STADIUM CONGLOMERATE
Tsc	SCRIPPS FORMATION
Tf	FRIARS FORMATION
Kgr	GRANITIC ROCK – SOUTHERN CALIFORNIA BATHOLITH